



AF <sup>END</sup>

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE  
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

First Named  
Inventor : Yukiko Kubota  
Appln. No. : 10/650,302  
Filed : August 28, 2003  
For : HIGH MOMENT DIRECTIONALLY  
TEXTURED SOFT MAGNETIC  
UNDERLAYER IN A MAGNETIC  
STORAGE MEDIUM

Appeal No. \_\_\_\_\_

Group Art Unit: 1773

Examiner:

Holly C. Rickman

Docket No.: S01.12-0965/STL 11036.00

## SUBSTITUTE BRIEF FOR APPELLANT

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*David C. Blum*

PATENT ATTORNEY

Sir:

This is an appeal from an Office Action dated June 8, 2005 in which claims 1-6, 8-22 and 25-28 were finally rejected. This SUBSTITUTE BRIEF is filed responsive to a Notice of Non-Compliant Appeal Brief mailed on January 9, 2007.

### (i) REAL PARTY IN INTEREST

Seagate Technology LLC, a limited liability company organized under the laws of the state of Delaware, and having offices at 920 Disc Drive, Scotts Valley, California 95066 has acquired the entire right, title and interest in and to the invention, the application, and any and all patents to be obtained therefor, as set forth in the Assignment filed with the patent application and recorded on Reel 014483, frame 0909.

### (ii) RELATED APPEALS AND INTERFERENCES

There are no known related appeals or interferences which will directly affect or be directly affected by or have a bearing on the Board's decision in this appeal.

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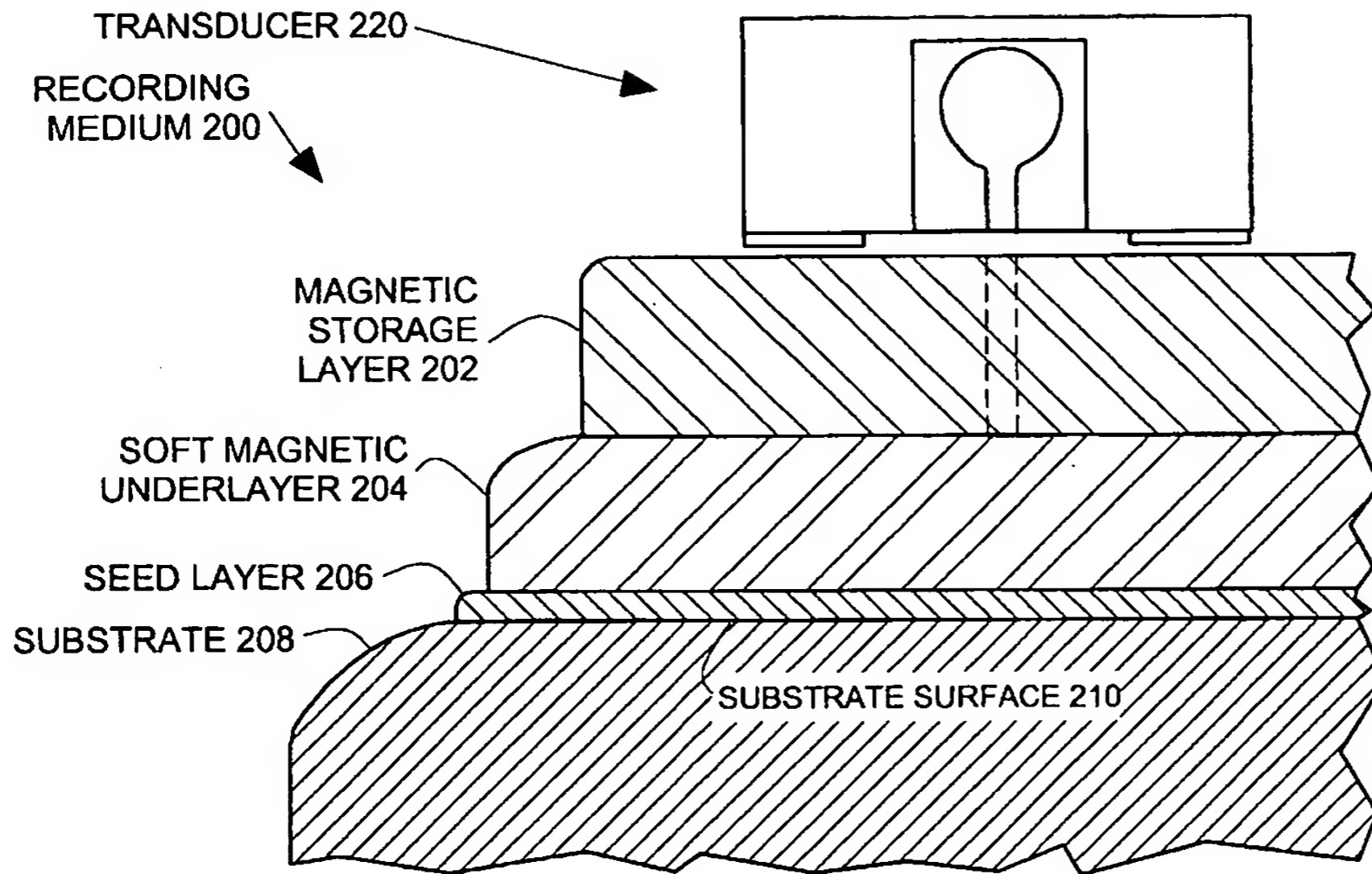
**(iii) STATUS OF THE CLAIMS**

- I. Total number of claims in the application.  
Claims in the application are: 1-31
- II. Status of all the claims.
- A. Claims cancelled: none
  - B. Claims withdrawn but not cancelled: 29-33
  - C. Claims pending: 1-33
  - D. Claims allowed: none
  - E. Claims rejected: 1-6, 8-22, 25-28
  - F. Claims Objected to: 7, 23-24
- III. Claims on appeal  
The claims on appeal are: 1-6, 8-22, 25-28

**(iv) STATUS OF AMENDMENTS**

A Response after Final was filed on May 16, 2005. In a June 8, 2005 Advisory Action before filing an Appeal Brief, the Response after Final was entered for purposes of Appeal.

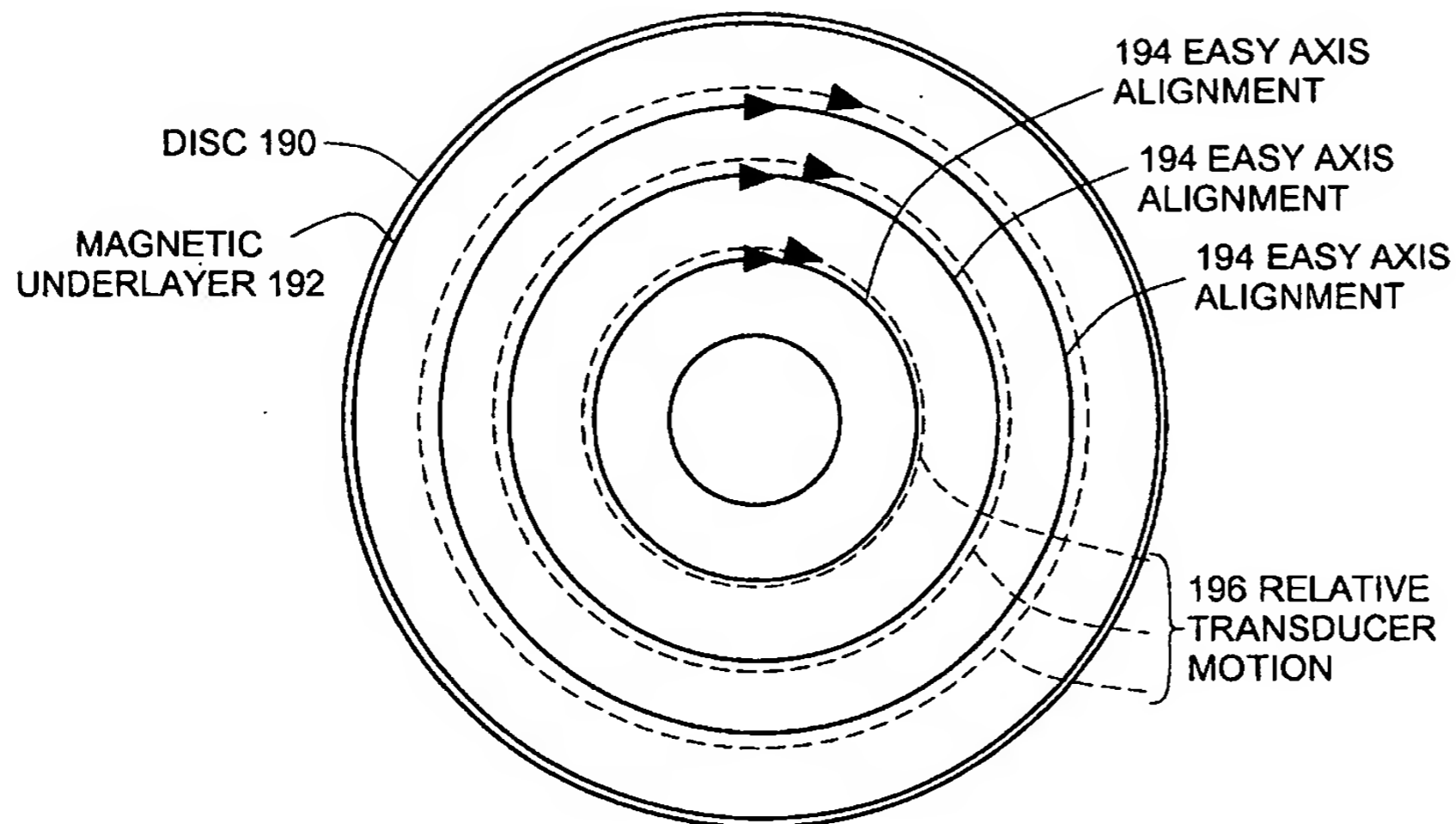
**(v) SUMMARY OF CLAIMED SUBJECT MATTER**



As illustrated in cross-section above and in FIG. 5 of the specification, a magnetic recording medium 200 comprises a substrate 208 that has a substrate surface 210. A seed layer 206 is disposed on the substrate surface 210.

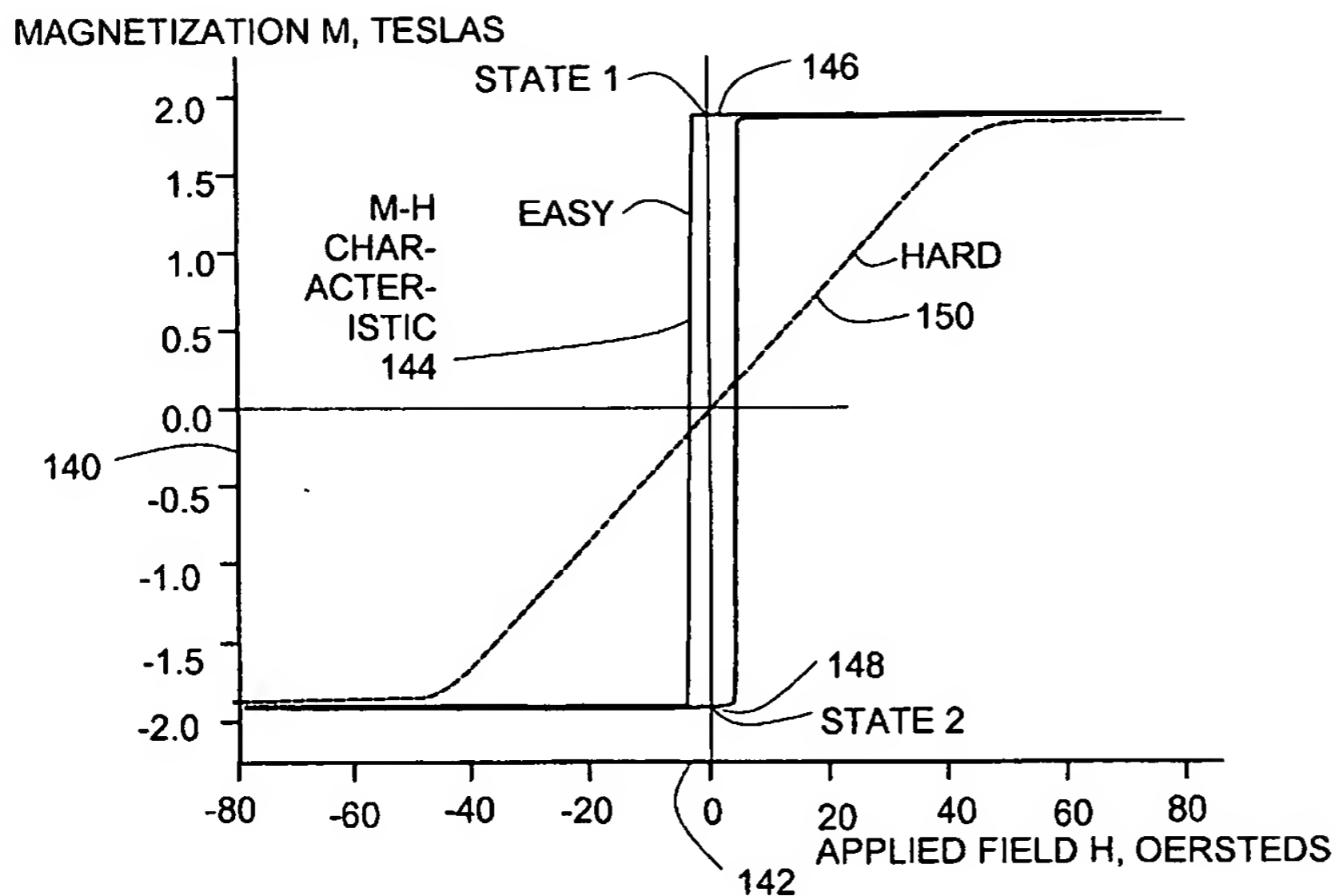
A soft magnetic underlayer 204 is disposed on the seed layer 206. The soft magnetic underlayer 204 has a texture that provides a magnetic easy axis alignment parallel to a line of relative motion of a transducer 220. A magnetic storage layer 202 is disposed on the soft magnetic underlayer 204. (FIG. 5 and specification, page 10, line 16 through page 12, line 12.)

The applied field (magnetic flux) from a transducer (write head) flows through a closed magnetic circuit from a narrower single pole on the transducer head, through a recording element of the magnetic storage layer 202, through the soft underlayer, and then back to a wider return pole on the transducer head. (Specification page 5, lines 19-22).



As illustrated above and in FIG. 4 of the specification, a disc 190 includes a magnetic underlayer 192 that has a circumferential easy axis alignment (solid lines 194) that is parallel to circumferential relative motion (dashed lines 196) of a transducer. (FIG. 4 and specification, page 9, line 3 through page 10 line 2). Circumferential easy axis alignment comprises a means for texturing a soft magnetic underlayer to provide alignment with a circumferential line of relative transducer motion in a disc drive.

The soft magnetic underlayer 204 comprises a magnetic material that has a texture and that has a magnetic moment that is larger than 1.7 teslas. (Specification page 4, lines 27-29.)



As shown above and in FIG. 2 of the specification, a static M-H characteristic 144 along the easy axis alignment is illustrated as a graph of magnetization M in teslas (axis 140) of the soft underlayer material as a function of an applied magnetic field H in oersteds (axis 142). The applied magnetic field is generated by the transducer 220 (FIG. 5). The M-H characteristic 144 includes saturation states STATE 1 and STATE 2 that correspond with the magnetic moment of the soft underlayer material. In the example of FIG. 2, a magnetic moment of approximately 1.9 teslas is shown. Between the saturation states, the soft underlayer material exhibits a high magnetic permeability, as illustrated by steep vertical slopes of the static M-H characteristics. (FIG. 2 and specification page 7, line 12 through page 8, line 2.)

Use of a conventional soft underlayer with relatively low magnetic moment in the range of less than 1.7 teslas leads to a requirement for an excessively thick soft underlayer in a thickness range of about 200-400 nanometers thickness. The large thickness induces a large surface roughness which interferes with small transducer-to-media spacing requirements for high density

recording.

Applicants have found that treating the soft underlayer to increase its magnetic moment to be larger than 1.7 teslas along the easy axis, and preferably larger than 2.0 teslas improves the performance of the soft underlayer material such that its thickness can be reduced to less than 200 nanometers, thus avoiding excessive interference with small transducer-media spacings. (Specification, page 10, lines 5-15).

As suggested by the Examiner in section 10 of the Notification of Non-Compliant Appeal Brief of January 9, 2007, applicant is herewith providing mappings of the independent claims 1 and 18 on appeal. The mappings are included in Appendix (xi) Mapping of independent Claims attached hereto. All of the features of Claim 1 are disclosed in the specification at page 3, lines 2-12 as shown in the appended mapping of Claim 1. All of the features of Claim 18 are disclosed in the specification at page 3, lines 2-12 and page 12, lines 11-12 as shown in the appended mapping of Claim 18.

**(vi) GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL**

In the Office Action of April 4, 2005, the Examiner rejected Claims 1-6, 8-22 and 25-28 under 35 USC 103(a) over Carey et al. US 2003/0022023 in view of Shimizu et al. US 2002/0004148.

The Examiner argued that "With respect to the claim limitation directed to a magnetic moment greater than 1.7 T, it is the Examiner's contention that the CoFe soft magnetic layers taught by Carey et al. inherently satisfy this limitation by virtue of the fact that magnetic moment is a material property and Applicants teach using the same material."

In reply to applicant's Reply after Final (May 16, 2005), the Examiner issued a subsequent Office Action of June 8, 2005 in which the Examiner argued that "The Examiner maintains that it is reasonable to believe that the FeCo alloy taught by

Carey et al. would inherently have a magnetic moment of 'at least 2.4 Teslas' in view of Applicant's specification."

In the Office Action of June 8, 2005, the Examiner also argued that "With regard to Applicant's statement that the examiner has not provided support for the assertion that magnetic moment does not depend on annealing conditions, Applicant is reminded that it has been held that where claimed and prior art products are identical, or are produced by identical or substantially identical processes, the burden of proof is shifted to the applicant to show that prior art products do not necessarily or inherently possess characteristics of claimed products where the rejection is based on inherency under 35 USC 102 or on prima facie obviousness under 35 USC 103, jointly or alternatively. *In re Best, Bolton, and Shaw*, 195 USPQ 430 (CCPA 1977) Thus, it is Applicant's burden to present probative evidence that the prior art would not inherently meet the claim limitations."

### (vii) ARGUMENTS

#### I.

Magnetic moment along an easy axis is not an intrinsic or inherent property of a particular composition of a magnetic material. For a particular composition of magnetic material, magnetic moment along an easy axis is not a fixed value, but can be varied by magnetic annealing history of the particular composition of magnetic material.

When magnetic material (such as magnetic material in a soft underlayer) is subjected to a magnetic field of strength  $H$ , the magnetic field exerts a torque on magnetic domains in the magnetic material. The torque is a maximum when the axis of the domain is perpendicular to the magnetic field. As the magnetic field increases from zero, domains (in the magnetic material) change size and rotate in increasing amounts to align with the

magnetic field. When substantially all of the magnetic domains subject to the magnetic field are aligned with the field, the material is said to be in a completely magnetized in a saturation state. The complete magnetization of the material is referred to as the magnetic moment of the material. (McGraw-Hill Concise Encyclopedia of Science and Technology, Third Edition, Sybil P. Parker, Ed., page 1100, McGraw-Hill, Inc. 1994; Magnetic Disc Drive Technology, Kanu G. Ashar, pages 37-38, IEEE Press 1997.)

For a particular composition of soft magnetic material, the magnetic moment along the easy axis of the material depends on the combined thermal and magnetic history (magnetic annealing) of the material. For example, as shown in FIGS. 10.2(a), (b), (c) and (d) on page 360 of Introduction to Magnetic Materials, four different M-H characteristics are shown for the same 65% nickel (Ni), 35% iron (Fe) composition with different magnetic annealing histories. The alloy composition is the same for all the different M-H characteristics, but the thermal and magnetic history is different as described in the legend under FIG. 10.2. In FIG. 10.2(a), the material has a magnetic moment of about  $12 \times 10^3$  gauss (1.2 tesla). In FIG. 10.2(b), the material has a magnetic moment of about  $10 \times 10^3$  gauss (1.0 tesla). In FIG. 10.2(c), the material has a magnetic moment of about  $13.3 \times 10^3$  gauss (1.33 tesla). In FIG. 10.2(d), the alloy material is transversely magnetized during annealing and does not reach its maximum magnetic moment with an applied field of 3 oersteds.

The static M-H characteristics in Figures 10.2(a)-(d) are comparable to the static M-H characteristics in FIG. 2 in the application and have the same axes. The vertical (magnetization axis) in FIG. 2 is scaled in teslas, while the vertical (magnetization axis) in figures 10.2(a)-(d) is scaled in gauss. Horizontal axes in both figures are scaled in oersteds. A "tesla" (T) is an SI unit of magnetic flux density, a "gauss" (G) is a CGS unit of magnetic flux density, and one tesla (T) is equal to  $10^4$

gauss (G). An oersted is a CGS unit of magnetic field strength. (Chambers Dictionary of Science and Technology, Prof. Peter M. B. Walker, Ed., pages 497, 805, 1157 Chambers Harrap Publishers Ltd., 1999.)

FIGS. 10.2(a), 10.2(b), 10.2(c), 10.2(d) demonstrate that magnetic moment is not an intrinsic (inherent) property of a particular material composition because the magnetic moment varies and depends on parameters other than the particular material composition. Magnetic moment along an easy axis depends on a magnetic and thermal history, and not only on material composition. (Introduction to Magnetic Materials, B. D. Cullity, pages 357-360, Addison-Wesley Publishing Company, Inc. 1972.)

The feature of increasing the magnetic moment along an easy axis of the soft magnetic underlayer to larger than 1.7 teslas, when taken in combination with the texture of the soft magnetic underlayer and other features of Claims 1-6, 8-22 and 25-28, patentably distinguishes the claimed invention from the prior art cited.

There is no teaching or suggestion in the prior art cited by the Examiner that the magnetic moment be raised to a level greater than 1.7 teslas in combination with a texture that provides a magnetic easy axis. The devices taught in the prior art cited by the Examiner do not inherently possess the claimed characteristic of a magnetic moment greater than 1.7 teslas in combination with a texture that provides a magnetic easy axis.

Even though two magnetic materials may have exactly the same chemical composition, the two magnetic materials can be physically different because the two materials have different texturing and different grain structures. The value of magnetic moment is not inherent to a particular chemical composition. The value of magnetic moment is a function of thermal magnetic history as well as texturing. In order for the Examiner to make a finding of inherency, the composition recited in the claims must be

physically identical to a composition in the prior art. MPEP 2112.01 II. The composition recited in the claims has an easy axis and the magnetic moment is greater than 1.7 teslas along the easy axis and is not physically identical to the compositions in the prior art. These features are not inherent in the materials taught in the cited references.

The limit of a magnetic moment larger than 1.7 teslas is a patentable feature. Numeric limits can serve as a basis for patentability. In re Glaug, 283 F.3d 1335, 62 USPQ2d 1151 (Fed. Cir. 2002):

While the measurement of a physical property may not of itself impart patentability to otherwise unpatentable claims, when the measured property serves to point up the distinction from the prior art, or advantages over the prior art, that property is relevant to patentability, and its numerical parameters can not only add precision to the claims but also may be considered, along with all the evidence, in determination of patentability.

## II.

Applicant met its burden of proof to show that prior art products do not necessarily or inherently possess characteristics of claimed products.

This burden was met by the applicant when the applicant submitted prior art Table 2.15, showing lack of inherency, with an amendment filed on January 4, 2005. This burden was again met by the applicant when the applicant submitted prior art Fig. 10.2(a)-(d) which showed lack of inherency with a Response filed on May 16, 2005.

Applicant twice met its burden of proof in showing that a magnetic moment greater than 1.7 teslas was not inherent in the


art cited by the Examiner. The burden of proof shifted to the Examiner, and the Examiner did not produce any evidence to support the assertion of inherency. The Examiner's making the rejections final was improper and should be reversed to provide applicant with either allowance of the claims or an opportunity to respond to a further non-final office action.

Conclusion

For the reasons advanced above, Appellant contends that each of the Claims on appeal is patentable. Therefore, reversal of all the rejections is requested.

Respectfully submitted,

WESTMAN, CHAMPLIN & KELLY, P.A.

By: 

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David C. Bohn, Reg. No. 32,015  
Suite 1400 - International Centre  
900 Second Avenue South  
Minneapolis, Minnesota 55402-3319  
Phone: (612) 334-3222 Fax: (612) 334-3312

**(viii) Claims Appendix**

1. (original) A magnetic recording medium for communication with a transducer moving relative to the recording medium along a line of relative transducer motion, comprising:

- a substrate having a substrate surface;
- a seed layer disposed on the substrate surface;
- a soft magnetic underlayer disposed on the seed layer, the soft magnetic underlayer comprising a magnetic material having a magnetic moment larger than 1.7 Teslas, the soft magnetic underlayer having a texture that provides a magnetic easy axis that has an easy axis alignment parallel to the line of relative transducer motion; and
- a magnetic storage layer disposed on the soft magnetic underlayer.

2. (original) The magnetic recording medium of Claim 1 further comprising a second seed layer deposited on the soft magnetic underlayer, and a second soft magnetic underlayer deposited on the second seed layer, forming a multilayer laminated soft magnetic underlayer structure.

3. (original) The magnetic recording medium of Claim 1 wherein the recording medium comprises a disc, and the easy axis alignment is circumferential.

4. (original) The magnetic recording medium of Claim 1 wherein the recording medium comprises a drum, and the line of relative transducer motion and the easy axis alignment are circumferential.

5. (original) The magnetic recording medium of Claim 1 wherein the recording medium comprises a plate.

6. (original) The magnetic recording medium of Claim 1 wherein the soft magnetic underlayer is free of 90° and 180° domain walls.

7. (original) The magnetic recording medium of Claim 1 wherein the texturing maintains the easy axis alignment in the presence of an externally applied field.

8. (original) The magnetic recording medium of Claim 1 wherein the texture provides a magnetic hard axis that has a hard axis alignment that is to the line of relative transducer motion.

9. (original) The magnetic recording medium of Claim 1 wherein the seed layer comprises copper and has a concentrically textured seed layer surface that induces the texture of the soft magnetic underlayer.

10. (original) The magnetic recording medium of Claim 1 wherein the seed layer comprises a seed layer material selected to reduce coercivity  $H_c$  in the soft magnetic underlayer, the seed layer material being selected from the group: copper, ruthenium, permalloy, copper/iridium-manganese, and tantalum/copper.

11. (original) The magnetic recording medium of Claim 10 wherein an external magnetic field establishes the texture of the soft magnetic underlayer.

12. (original) The magnetic recording medium of Claim 1 wherein the magnetic material has a magnetic moment that is at least 2.0 teslas.

13. (original) The magnetic recording medium of Claim 1 wherein the magnetic material comprises Iron and Cobalt.

14. (original) The magnetic recording medium of Claim 13 wherein the magnetic material comprises about 65 at% Iron and 35 at% Cobalt.

15. (original) The magnetic recording medium of Claim 1 wherein the seed layer and the soft magnetic underlayer form a seeded double layer structure, and the seed layer has a thickness of about 5 nanometers and the soft magnetic underlayer has a thickness of about 50 nanometers.

16. (original) The magnetic recording medium of Claim 1 wherein the seed layer and the soft magnetic underlayer form a seeded double layer structure, and the seed layer has a thickness of about 5 nanometers and the soft magnetic underlayer has a laminated structure of about 50 nanometers thick soft magnetic films separated with non-magnetic spacers.

17. (original) The magnetic recording medium of Claim 1 wherein the seed layer and the soft magnetic underlayer form a seeded double layer structure, the soft magnetic underlayer is biased by an anti-ferromagnetic layer selected from the group of ruthenium and iridium-manganese.

18. (original) A method of manufacturing a magnetic recording medium for communication with a transducer moving relative to the recording medium along a line of relative transducer motion, comprising:

- providing a substrate having a substrate surface;
- depositing a seed layer on the substrate surface;

depositing a soft magnetic underlayer on the seed layer, the soft magnetic underlayer comprising a magnetic material having a magnetic moment larger than 1.7 teslas, the soft magnetic underlayer having a texture that provides a magnetic easy axis that has an easy axis alignment parallel to the line of relative transducer motion; and depositing a magnetic storage layer on the soft magnetic underlayer.

19. (original) The method of Claim 18 further comprising shaping the substrate into a disc aligning the easy axis in a circumferential direction on the disc.

20. (original) The method of Claim 18 further comprising shaping the substrate into a drum, and aligning the easy axis in a circumferential direction on the drum.

21. (original) The method of Claim 18 further comprising shaping the substrate into a plate.

22. (original) The method of Claim 18 further comprising forming the seed layer from copper and aligning a seed layer texture with the line of relative transducer motion.

23. (original) The method of Claim 18 further comprising selecting a seed layer material from the group: ruthenium, permalloy and tantalum-copper to reduce coercivity  $H_c$  in the soft magnetic underlayer.

24. (original) The method of Claim 23 further comprising applying an external magnetic field to establishes the texture of the soft magnetic underlayer.

25. (original) The method of Claim 18 further comprising selecting the magnetic material to have a magnetic moment that is at least 2.0 teslas.

26. (original) The method of Claim 18 further comprising selecting the magnetic material to comprise Iron and Cobalt.

27. (original) The method of Claim 18 wherein the magnetic material comprises about 65 at% Iron and 35 at% Cobalt.

28. (original) The method of Claim 18 wherein the seed layer and the soft magnetic underlayer form a seeded double layer structure, and the seed layer has a thickness of about 5 nanometers and the soft magnetic underlayer has a thickness of about 50 nanometers.

29. (withdrawn) A magnetic recording medium for communication with a transducer moving relative to the recording medium along a line of relative transducer motion, comprising:

- a substrate, a seed layer disposed on the substrate; a soft magnetic underlayer disposed on the seed layer, the soft magnetic underlayer comprising a magnetic material having a magnetic moment larger than 1.7 teslas, and a magnetic storage layer disposed on the soft magnetic underlayer; and

- means for texturing the soft magnetic underlayer to provide a magnetic easy axis that has an easy axis alignment parallel to the line of relative transducer motion.

30. (withdrawn) The magnetic recording medium of Claim 29 wherein the recording medium comprises a disc, and the easy axis alignment is circumferential.

31. (withdrawn) The magnetic recording medium of Claim 29 wherein the seed layer comprises copper and has a concentrically textured seed layer surface that induces the texture of the soft magnetic underlayer.

32. (withdrawn) The magnetic recording medium of Claim 29 wherein the magnetic material has a magnetic moment that is at least 2.0 teslas.

33. (withdrawn) The magnetic recording medium of Claim 29 wherein the magnetic material comprises Iron and Cobalt.

**(ix) Evidence Appendix**

In re Best, Bolton, and Shaw, 195 USPQ 430 (CCPA 1977). Mentioned in the Examiner's Advisory Action before filing of an Appeal 06/08/2005.

U.S. Patent Publication Carey et al. 2003/0022023. Mentioned in the Examiner's Office Action of 11/02/2004.

US Patent Publication Shimizu et al. 2002/0004148. Mentioned in the Examiner's Office Action of 11/02/2004.

Electronic Designers' Handbook, Second Edition, L.J. Giacoletto, Editor, McGraw-Hill Book Company (1977) ISBN 0-07-023149-4, pp. 292-297. Mentioned in Examiner's Office Action of 11/02/2004.

McGraw-Hill Concise Encyclopedia of Science and Technology, Third Edition, Sybil P. Parker, Ed., page 1100, McGraw-Hill, Inc. 1994. Mentioned in Brief for Appellant filed 09/19/2005. Mentioned in Examiner's Answer of 12/20/2005.

Magnetic Disc Drive Technology, Kanu G. Ashar, pages 37-38, IEEE Press 1997. Mentioned in Brief for Appellant filed 09/19/2005. Mentioned in Examiner's Answer of 12/20/2005.

Chambers Dictionary of Science and Technology, Prof. Peter M. B. Walker, Ed., pages 497, 805, 1157 Chambers Harrap Publishers Ltd., 1999. Mentioned in Brief for Appellant filed 09/19/2005. Mentioned in Examiner's Answer of 12/20/2005.

Introduction to Magnetic Materials, B. D. Cullity, pages 357-360, Addison-Wesley Publishing Company, Inc. 1972. Mentioned in Appellant's Response After Final 05/16/2005. Mentioned in Examiner's Answer 12/20/2005.

In re Glaug, 283 F.3d 1335, 62 USPQ2d 1151 (Fed. Cir. 2002).

**Court of Customs and Patent Appeals***In re Best, Bolton, and Shaw*

No. 77-509      Decided Oct. 13, 1977

**PATENTS****1. Patentability — Composition of matter (§51.30)****Patentability — New use or function — Composition of matter (§51.555)**

Indirect comparisons, between claimed process and reference, that are based on established scientific principles can validly be applied to distinguish claimed chemical process or product from that disclosed in prior art.

**2. Patentability — Anticipation — In general (§51.201)****Patentability — Invention — In general (§51.50)****Patentability — New use or function — In general (§51.552)****Pleading and practice in Patent Office — In general (§54.1)**

Mere recitation of newly-discovered function or property, inherently possessed by things in prior art, does not cause claim drawn to those things to distinguish over prior art; Patent Office can require applicant to prove that subject matter shown to be in prior art does not possess characteristic relied on where it has reason to believe that functional limitation asserted to be critical for establishing novelty in claimed subject matter may be inherent characteristic of prior art; this burden of proof is applicable to product and process claims reasonably considered as possessing allegedly inherent characteristics.

**3. Patentability — Anticipation — In general (§51.201)****Patentability — Invention — In general (§51.501)****Patentability — New use or function — In general (§51.551)****Pleading and practice in Patent Office — In general (§54.1)**

Patent and Trademark Office can require applicant to prove that prior art products do not necessarily or inherently possess characteristics of his claimed product where claimed and prior art products are identical or substantially identical, or are produced by identical or substantially identical processes; burden of proof is on applicant

where rejection is based on inherency under 35 U.S.C. 102, or on prima facie obviousness under 35 U.S.C. 103, jointly or alternatively, and Patent and Trademark Office's inability to manufacture products or to obtain and compare prior art products evidences fairness of this rejection; there is nothing inconsistent in concurrent rejection for obviousness under 35 U.S.C. 103 and for anticipation by inherency under 35 U.S.C. 102.

#### Particular patents — Catalyst

Best, Bolton, and Shaw, Catalyst for Hydrocarbon Conversion Processes and Process for Preparing Same, rejection of claims 1-7 affirmed.

Appeal from Patent and Trademark Office Board of Appeals.

Application for patent of Donald Francis Best, Anthony Peter Bolton, and Herbert Charles Shaw, Serial No. 347,216, filed Apr. 2, 1973, continuation in part of application, Serial No. 145,900, filed May 21, 1971. From decision rejecting claims 1-7, applicants appeal. Affirmed.

Richard G. Miller, New York, N.Y. (James C. Arvantes, of counsel) for appellants.

Joseph F. Nakamura (Gerald H. Bjorge, of counsel) for Commissioner of Patents and Trademarks.

Before Markey, Chief Judge, Rich, Baldwin, and Lane, Associate Judges, and Morgan Ford, Associate Judge, United States Customs Court.

Markey, Chief Judge.

Appeal from the decision of the Patent and Trademark Office (PTO) Board of Appeals (board) sustaining rejections of claims 1-7 under 35 USC 102 or 35 USC 103, and claims 3-7 under 35 USC 112, of appellants' application serial No. 347,216, filed April 2, 1973, for "Catalyst for Hydrocarbon Conversion Processes and Process for Preparing Same." We affirm.

#### The Invention

The invention relates to zeolitic molecular sieve catalyst compositions useful in hydrocarbon conversion and to a process for producing them. Claim 1 is illustrative of the product claims:

1. A crystalline zeolitic aluminosilicate having a  $\text{SiO}_2/\text{Al}_2\text{O}_3$  molar ratio of from 4.6 to 5.4, a face centered cubic unit cell having an  $a_0$  of greater than 24.45 to 24.55 Å, an  $\text{Na}_2\text{O}/\text{Al}_2\text{O}_3$  molar ratio of not greater than 0.25, an adsorptive capacity in the dehydrated state for oxygen of at least 26 weight per cent at 100 mm Hg oxygen pressure and  $-183^\circ\text{C}$ ., an ion exchange capacity of from 0.15 to 0.35 and having the essential X-ray powder diffraction pattern of zeolite Y with the proviso that the d-spacing thereof having the Miller Indices 331 is at least as great in intensity as the line thereof having the Miller Indices 533.

Claim 3 is illustrative of the process claims:

3. Process for preparing a hydrolytically-stable zeolitic aluminosilicate which comprises providing an ion-exchanged zeolite Y having the following composition in terms of mole ratios of oxides

0.75 - 0.9(A)<sub>2</sub>O: 0.1 - 0.25 Na<sub>2</sub>O: Al<sub>2</sub>O<sub>3</sub>:  
4.6-5.4 SiO<sub>2</sub>: yH<sub>2</sub>O

wherein "A" represents H<sup>+</sup> or NH<sub>4</sub><sup>+</sup> or a mixture thereof, and wherein y has a value of from zero to nine, heating the zeolite at a temperature between  $550^\circ\text{C}$ . and  $800^\circ\text{C}$ . for a period of at least 0.25 hours in an inert atmosphere comprising sufficient steam to prevent dehydroxylation of the zeolite, removing at least a major proportion of any ammonia generated by the heated zeolite from contact with the zeolite, and cooling the steamed zeolite to a temperature below  $350^\circ\text{C}$ . at a rate sufficiently rapid that the cooled zeolite exhibits an X-ray powder diffraction pattern having the d-spacing corresponding to the Miller Indices, hkl, of 331 at least as strong in intensity as that corresponding to the Miller Indices 533, prior to any post-steaming ion exchange treatment.

Claim 2 is restricted to a zeolite of claim 1 with a  $\text{Na}_2\text{O}/\text{Al}_2\text{O}_3$  molar ratio of less than 0.038. Claims 4-7 add further process restrictions as to starting materials or process steps. All of the claims stand or fall with claims 1 and 3.

As recognized in the prior art, crystalline zeolitic aluminosilicates with high concentrations of sodium cations do not make good hydrocarbon conversion catalysts. For this reason sodium cations are replaced with non-metallic cations such as hydrogen or ammonium. The hydrogen or ammonium cations are removed by calcination, produc-

<sup>1</sup> A continuation-in-part of serial No. 145,900, filed May 21, 1971.

ing a decationized zeolite. Such decationized zeolites have poor hydrothermal stability, i.e., they lose their crystallinity upon reheating after contact with water.

The process of appealed claims 3-7 is a stabilization procedure for such low-sodium zeolites wherein a thermal treatment in the presence of steam is followed by a particular cool-down step. The zeolitic compositions of claims 1-2 represent the products of the claimed process.

#### *The 102/103 Rejections*

The references relied upon were:

Maher et al. (Maher)	3,293,192	Dec. 20, 1966
Hansford	3,354,077	Nov. 21, 1967
McDaniel et al. (McDaniel)	3,449,070	June 10, 1969
Kerr et al. (Kerr I)	3,493,519	Feb. 3, 1970
Kerr (Kerr II)	3,513,108	May 19, 1970

All claims were rejected under 35 USC 102 or 35 USC 103 as unpatentable over Hansford. Claims 1-2 were additionally rejected in view of each of Maher, McDaniel, Kerr I, and Kerr II.<sup>2</sup>

Hansford discloses a method for producing a hydrothermally stable Y-sieve zeolite composition by calcining an ammonium zeolite Y for 2 or more hours in an atmosphere containing water vapor at a temperature of from 700°F to 1200°F (338°C - 649°C). The starting material is disclosed by Hansford as having a  $\text{SiO}_2/\text{Al}_2\text{O}_3$  molar ratio of 4 to 6 and a reduced  $\text{Na}_2\text{O}$  content of 0.6% to 2.5% by weight (appellants claim 0.1 - 0.25  $\text{Na}_2\text{O}/\text{Al}_2\text{O}_3$  molar ratio and disclose 2.48% by weight in example 10 of their specification). In rejecting claims 1-7 on Hansford, the examiner asserted that a major portion of any ammonia generated during calcination would inherently be removed from contact with the zeolite, because the gaseous atmosphere disclosed by Hansford was in the form of a moving stream. Also with respect to Hansford, the examiner believed the cooling rate of the zeolite after stabilization to be within the terms of the appealed process claims. The claimed product being the unique result of the claimed process, the examiner, therefore, rejected both process and

product claims as anticipated by Hansford, or, in any case, as obvious in view of Hansford.

In sustaining the rejection, the board added its view of Hansford.

All the positive process limitations are expressly disclosed except for the functionally expressed rate of cooling. However, there is nothing to indicate that this rate of cooling in any way differs from the normal rate resulting from removal of the heat source. Thus, the examiner's conclusion that those parameters of the resultant product which are recited in the appealed claims but are not expressly disclosed in the reference would be inherent is a reasonable one, absent convincing evidence to the contrary. Appellants have presented no such convincing evidence. No comparison has been made between appellants' process and product and the process and product disclosed in the Hansford patent. The comparative data contained in appellants' specification and in an affidavit under 37 CFR 1.132 do not relate to the reference but merely illustrate the result of deviating from appellants' process. Such deviations appear to be also outside the scope of the Hansford teaching.

### **Opinion**

#### *1. The Process Claims*

[1] The appellants urge that, because Hansford is silent on appellants' crucial cool-down step and on his apparatus, a direct comparison between the claimed process and that of Hansford is impossible. Appellants correctly state that indirect comparisons, based on established scientific principles, can validly be applied to distinguish a claimed chemical process or product from that disclosed in the prior art. In re Blondel, 499 F.2d 1311, 182 USPQ 294 (CCPA 1974). However, our analysis of the comparative data offered by appellants convinces us that the burden of rebutting the PTO's reasonable assertion of inherency under 35 USC 102, or of prima facie obviousness under 35 USC 103, has not been met.

Our reading of Hansford leads us to conclude, as did the board, that all process limitations of claim 3 are expressly disclosed by Hansford, except for the functionally expressed rate of cooling. Because any sample of Hansford's calcined zeolitic catalyst would necessarily be cooled to facilitate subsequent handling, the conclusion of the examiner that such cooling is encompassed by

<sup>2</sup> The examiner rejected claims 1-7 under 35 USC 103 as unpatentable over Kerr I, and claims 1, 2, 3, 6, and 7 under 35 USC 103 as unpatentable over Kerr II. The board affirmed only in relation to claims 1-2 and reversed in relation to claims 3-7 over Kerr I and to claims 3, 6, and 7 over Kerr II.

the terms of the appealed claims was reasonable.

The board did not specifically mention the absence of ammonia as a result of "removing at least a major proportion of any ammonia generated by the heated zeolite from contact with the zeolite," as recited in claim 3. Its affirmance of the examiner, however, carried with it a concurrence in the examiner's view that Hansford discloses a gaseous atmosphere in a "stream." In concluding that Hansford expressly disclosed all process limitations except the cooling rate, the board necessarily considered Hansford's disclosure of a gas "stream" as equivalent to a disclosure of the removal of generated ammonia from contact with the zeolite. Though appellants argued before the board and before us that Hansford is silent on the matter, they have not provided any effective argument nor submitted any evidence that a gas stream does not inherently remove generated ammonia.

[2] This court, in *In re Swinehart*, 58 CCPA 1027, 439 F.2d 210, 169 USPQ 226 (1971), set forth the burden of proof required to overcome an inherency rejection:

[I]t is elementary that the mere recitation of a newly discovered function or property, inherently possessed by things in the prior art, does not cause a claim drawn to those things to distinguish over the prior art. Additionally, where the Patent Office has reason to believe that a functional limitation asserted to be critical for establishing novelty in the claimed subject matter may, in fact, be an inherent characteristic of the prior art, it possesses the authority to require the applicant to prove that the subject matter shown to be in the prior art does not possess the characteristic relied on. [58 CCPA at 1031, 439 F.2d at 212-13, 169 USPQ at 229.] This burden was involved in *In re Ludtke*, 58 CCPA 1159, 441 F.2d 660, 169 USPQ 563 (1971), and is applicable to product and process claims reasonably considered as possessing the allegedly inherent characteristics.

The proof required here relates to appellants' cool-down step. The only comparative data on the cool-down rate are found in examples 1(a) and 1(c) of appellants' specification. Those data merely establish that there may be cooling rates which are not the cooling rate functionally set forth in claim 3. Absent from the data is a comparison of X-ray diffraction patterns, the phenomenon employed in defining cooling rates. Thus the data found in the

specification are insufficient to rebut the inherency rejection of the process claims.

In view of Hansford's silence on cool-down rate and on his apparatus, appellants need only have shown that the cool-down rate, for a typical laboratory-scale sample when employed in Hansford's process, would not yield a cooled zeolite with the X-ray diffraction pattern of claim 3. Appellants failed to do even that.

Appellants submitted an affidavit of Skeels,<sup>3</sup> the thrust of which was the assertion that, although cooling rates can vary greatly, depending on the apparatus employed and the quantity of zeolite treated, some normal cooling rates with typical laboratory equipment are much slower than that disclosed in appellants' specification and encompassed by claim 3. The Skeels affidavit fails for lack of a showing that such normal cooling rates are not rapid enough to result in the particular X-ray diffraction pattern recited in appealed claim 3.

We affirm the board's decision upholding the rejection of process claims 3-7 as anticipated under 35 USC 102 or as obvious under 35 USC 103, and do not reach the rejection of claims 3-7 under 35 USC 112.

## II. The Product Claims

Product claims 1-2 were rejected as unpatentable over each of Hansford, Maher, McDaniel, Kerr I, and Kerr II. We find it necessary to consider only Hansford.

[3] Where, as here, the claimed and prior art products are identical or substantially identical, or are produced by identical or substantially identical processes, the PTO can require an applicant to prove that the prior art products do not necessarily or inherently possess the characteristics of his claimed product. See *In re Ludtke*, supra. Whether the rejection is based on "inherency" under 35 USC 102, on "prima facie obviousness" under 35 USC 103, jointly or alternatively,<sup>4</sup> the burden of proof is the

<sup>3</sup> The board considered the Skeels affidavit untimely and treated it as mere argument. But if the board's statement that appellants' cooling rate did not differ from "the normal rate resulting from removal of the heat source" were considered a new ground of rejection and the affidavit be considered evidence, the data presented would not rebut the inherency rejection, absent a showing of X-ray diffraction patterns for cooled zeolites.

<sup>4</sup> There is nothing inconsistent in concurrent rejection for obviousness under 35 USC 103 and for anticipation by inherency under 35 USC 102. *In re Skoner*, 517 F.2d 947, 186 USPQ 80 (CCPA 1975); *In re Pearson*, 494 F.2d 1399, 181 USPQ 641 (CCPA 1974).

same, and its fairness is evidenced by the PTO's inability to manufacture products or to obtain and compare prior art products. See *In re Brown*, 59 CCPA 1036, 459 F.2d 531, 173 USPQ 685 (1972)

In product claim 1 appellants have "fingerprinted" their crystalline zeolitic aluminosilicate by reciting six parameters, two directly compositional in nature,  $\text{SiO}_2/\text{Al}_2\text{O}_3$  and  $\text{Na}_2\text{O}/\text{Al}_2\text{O}_3$  molar ratios. The other parameters are the cubic unit cell size ( $a_0$ ), the ion exchange capacity, the oxygen adsorption capacity, and the X-ray powder diffraction pattern. Hansford discloses  $\text{SiO}_2/\text{Al}_2\text{O}_3$  and  $\text{Na}_2\text{O}/\text{Al}_2\text{O}_3$  molar ratios within the ranges recited in claim 1, but does not specifically disclose the other parameters.

Though urging that the other parameters are the unique result of their claimed process, appellants have offered no comparison of those other parameters with the corresponding parameters of Hansford's product.

We affirm the decision of the board upholding the rejections of product claims 1-2 on Hansford and do not reach the rejections of claims 1-2 on Maher, McDaniel, Kerr I, or Kerr II.

The decision of the board is affirmed.

# Electronics Designers' Handbook

Second Edition

*First Edition by*  
**ROBERT W. LANDEE**  
**DONOVAN C. DAVIS**  
**ALBERT P. ALBRECHT**

*Second Edition Completely Revised and Edited by*

**L. J. GIACOLETTO**

*Professor of Electrical Engineering, Michigan State University*  
*Fellow, Institute of Electrical and Electronics Engineers*  
*Fellow, American Association for the Advancement of Science*  
*Member, American Physical Society*

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## Notes to Table 2.15.

1. The units indicated apply to the quantity tabulated when the values in the column are *divided* by the common factor, if any, shown at the column heading. Properties are mostly compiled from the following sources:

- (a) Richard M. Bozorth, *Ferromagnetism*, D. Van Nostrand Company, Inc., Princeton, N.J., 1951.
- (b) R. Ochsenfeld and K. H. v. Klitzing, *Magnetische Werkstoffe*, sec. 445, pp. 737-843 of group 6, vol. IV, part 3, Landolt-Börnstein, *Zahlenwerte und Funktionen aus Physik, Chemie, Astronomie, Geophysik und Technik*, Ernst Schmidt (ed.), Springer-Verlag OHG, Berlin, 1957.
- (c) Commercial literature.

Data as tabulated are for materials at room temperature (about 25°C).

2. For significance of American Iron and Steel Institute (AISI) designations, see ASTM A 345-55, Standard Specifications for Flat-Rolled Electrical Steel, pp. 73-76 of part 8, 1973 *Annual Book of ASTM Standards*, American Society for Testing and Materials, Philadelphia, 1973. Weight percentages are indicated with the balance as iron. —

3. For optimum magnetic properties the materials must be carefully heat-treated after fabrication. This generally involves annealing in a controlled atmosphere ( $N_2$  = nitrogen,  $H_2$  = hydrogen) and controlled cooling ( $Q$  = quenching,  $C$  = controlled cooling rate) frequently in the presence of a magnetic field.

4. Above the Curie temperature the material no longer exhibits residual magnetic polarization.

5. For measurement method see ASTM B 193-722, Standard Method of Test for Resistivity of Electrical Conductor Materials, pp. 227-232 of part 8, *op. cit.*

6. Standard methods of measurement are described in part 8, 1973 *Annual Book of ASTM Standards*, *op. cit.* See also Raymond L. Sanford and Irvin L. Conter, Basic Magnetic Quantities and the Measurement of the Magnetic Properties of Materials, National Bureau of Standards Monograph 47, May 21, 1962, pp. 439-476 of NBS Spec. Publ. 300, vol. 3, Precision Measurement and Calibration, U.S. Government Printing Office, Washington, D.C., December 1968.

For large values of  $H_p$ , the hysteresis loop energy depends in a complex manner on  $H_p$ , material, and geometry. In 1892, C. P. Steinmetz developed an empirical relation for hysteresis loop energy.<sup>1</sup>

$$\frac{W_h}{V} = \eta_s B_p^n \quad (2.41)$$

This relation with the Steinmetz constant  $\eta_s$ , joules per cubic meter tesla<sup>n</sup>, and the exponent adjusted for a best fit, is useful if measurement or graphical data are not available.

As the magnetic field is varied, voltages are induced in the magnetic materials that produce eddy currents and associated  $I^2R$  eddy current losses. If the magnetic core consists of cylindrical rods of radius  $R_0$ , oriented axially with respect to the magnetic field, then the per unit volume eddy current power loss is

$$\frac{P_e}{V} = \frac{\sigma R_0^2}{8} \left[ \frac{dB(t)}{dt} \right]^2 \Rightarrow \frac{\sigma}{16} (\omega R_0 B_p)^2 \quad (2.42)$$

where  $\sigma$  is the conductivity of the magnetic material. The second result is applicable when the flux density (assumed uniform throughout the cross section) is sinusoidal,  $B(t) = B_p \sin \omega t$ . Similarly if the magnetic core consists of laminations of thickness  $X_T$  and width  $X_w$  oriented longitudinally with respect to the magnetic field, then provided the laminations (conductivity  $\sigma$ ) are electrically insulated from each other the per unit volume eddy current power loss is

$$\frac{P_e}{V} = \frac{\sigma X_T^2}{16[1 + (X_T/X_w)^2]} \left[ \frac{dB(t)}{dt} \right]^2 \Rightarrow \frac{\sigma (\omega X_T B_p)^2}{32[1 + (X_T/X_w)^2]} \quad (2.43)$$

This result<sup>2</sup> takes into account the eddy current both along the width and across the thickness of the laminations. For  $X_T/X_w < 1$ ,  $P_e/V$  in Eq. (2.43) is independent of  $X_w$ . For a general symmetrically cyclically magnetized condition the net per unit volume

<sup>1</sup> C. P. Steinmetz, On the Law of Hysteresis, *Trans. AIEE*, vol. 9, pp. 3-51, January 1892.

<sup>2</sup> S. S. Attwood, *Electric and Magnetic Fields*, p. 358, John Wiley & Sons, Inc., New York, 1949.

TABLE 2.15 Properties of Soft Ferromagnetic Magnetic Materials (Note 1)<sup>a</sup>

No.	Material	Description (Note 2)	Density $\rho_u$ , kg/m <sup>3</sup>	Thermal conduc- tivity $\lambda$ , W/(K m)	Coeffi- cient of linear thermal expansion, $\alpha_L$ , $\times 10^6$ , (K) <sup>-1</sup>	Tensile strength, $S \times 10^{-8}$ , N/m <sup>2</sup>	Tensile modulus, $E_T$ , $\times 10^{-10}$ , N/m <sup>2</sup>	(Melt. temp.) (Anneal. temp.), °C (Note 3)	Curie temp., $T_C$ , °C (Note 4)	Resis- tivity $\rho$ , $\Omega$ m (Note 5)
1	Iron, Fe	0.9995 Fe, body-centered cubic single crystal	7,880	78	11.7	5.4-6.2	21.14	1539 1482 H <sub>2</sub> + 880	770	$1.0 \times 10^{-7}$
2	Iron, Fe	99.8% Fe	7,880	78	11.7	5.4-6.2	21.14	1536.5	770	$1.0 \times 10^{-7}$
3	Iron, Fe	Mild steel, 0.2% C	7,859	78	11.7	3.1		950 1523 950	770	$1.0 \times 10^{-7}$
4	Nickel, Ni	99% Ni, face-centered cubic single crystal	8,902	89	12.8	5.0-9.0	19.95	1453	358	$7.06 \times 10^{-8}$
5	Cobalt, Co	99% Co, hexagonal single crystal	8,850	97	12	2.6-7.5		1000 1492 1000	1115	$5.86 \times 10^{-8}$
6	Silicon-iron	3% Si, cube on edge	7,650	18.0		$\parallel$ 3.0 $\perp$ 3.0	$\parallel$ 11 $\perp$ 11	1488 800 N <sub>2</sub>	740	$4.7 \times 10^{-7}$
7	Silicon-iron	3% Si, oriented, Silectron, AISI Grade M-5	7,650	18.0		$\parallel$ 3.0 $\perp$ 3.2	$\parallel$ 11 $\perp$ 19	1488 800 N <sub>2</sub>	740	$4.7 \times 10^{-7}$
8	Silicon-iron	3% Si, oriented, Silectron, AISI Grade M-6	7,650	18.0		$\parallel$ 3.0 $\perp$ 3.2	$\parallel$ 11 $\perp$ 19	1488 800 N <sub>2</sub>	740	$4.5 \times 10^{-7}$
9	Silicon-iron	3% Si, oriented, Silectron, AISI Grade M-7	7,650	18.0		$\parallel$ 3.0 $\perp$ 3.2	$\parallel$ 11 $\perp$ 19	1488 800 N <sub>2</sub>	740	$4.7 \times 10^{-7}$
10	Silicon-iron	2.85 to 3.25% Si, Trans. C nonoriented, AISI Grade M-19	7,550	16.3		4.0-4.2	0.63	1488 800 N <sub>2</sub>	732	$5.4 \times 10^{-7}$
11	Silicon-iron	2.7 to 3.1% Si, Dynamo Special non- oriented, AISI Grade M-22	7,650	18.0		3.9-4.1		870 N <sub>2</sub> 1488	732	$4.6 \times 10^{-7}$
12	Silicon-iron	2.5 to 2.9% Si, Dynamo Grade non- oriented, AISI Grade M-27	7,650	19.7		3.7-3.8		870 N <sub>2</sub> 1480	732	$4.5 \times 10^{-7}$
13	Silicon-iron	1.7 to 2.3% Si, Electrical Grade non- oriented, AISI Grade M-36	7,750	30.5		3.4-3.5		870 N <sub>2</sub> 1506	735	$3.7 \times 10^{-7}$
14	Silicon-iron	1.5 to 2.0% Si, Armature Grade non- oriented, AISI Grade M-43	7,750	40.6		3.2-3.3		870 N <sub>2</sub> 1510	737	$2.8 \times 10^{-7}$
15	Silicon-iron	2.25% Si, Relay Grade 5 nonoriented	7,650		11.6	5.3		870 N <sub>2</sub> 1502 1000 H <sub>2</sub>	749	$4.0 \times 10^{-7}$

16	Steel	1% C	7,830	45.1	12.4	13.8	$\frac{1465}{870 N_2}$	770	$1.2 \times 10^{-7}$
17	Aluminum-iron	3.5% Al	7,460				$\frac{1536}{1100}$	750	$5.5 \times 10^{-7}$
18	Aluminum-iron	13% Al, Alfer	6,660			4.8	$\frac{1515}{1500 Q}$	510	$9.0 \times 10^{-7}$
19	Aluminum-iron	16% Al, Alperm	6,500			6.1	$\frac{1500}{600 Q}$	400	$1.4 \times 10^{-4}$
20	Nickel-iron	30% Ni, Thermoperm		11.0	3.4		$\frac{1460}{1000}$	417	
21	Nickel-iron	36% Ni, Hyperm 36	8,150	1.0	0.88	4.8	$\frac{1450}{1450}$	417	$6.5 \times 10^{-7}$
22	Nickel-iron	45% Ni, 45-Permalloy	8,170	15.9	8.4	5.0	$\frac{1440}{1050}$	480	$4.5 \times 10^{-7}$
23	Nickel-iron	50% Ni, Hipernik	8,250	15.5	9.5	5.0	$\frac{1438}{1200 H_2}$	500	$4.5 \times 10^{-7}$
24	Nickel-iron	50% Ni, Deltamax	8,250	15.5	8.4	4.4	$\frac{1438}{1075 H_2 + C}$	500	$4.5 \times 10^{-7}$
25	Nickel-iron	50% Ni, 50-Isoperm	8,250	15.5	9.0	4.0	$\frac{1438}{1100}$	500	$4.0 \times 10^{-7}$
26	Nickel-iron	78.5% Ni, 78-Permalloy	8,600		12.5	4.8	$\frac{1440}{1050 + 600 Q}$	600	$1.6 \times 10^{-7}$
27	Cobalt-iron	50% Co, Permendur	8,300		11.0		$\frac{1485}{800}$	980	$4.0 \times 10^{-7}$
28	Molybdenum-iron	3% Mo, Moly-Iron	7,900		11.5	3.0	As cast	805	$2.0 \times 10^{-7}$
29	Sendust	10% Si + 5% Al	8,800					500	$6.0 \times 10^{-7}$
30	36 Isoperm	36% Ni + 9% Cu	8,200					300	$7.0 \times 10^{-7}$
31	Radio-Metal	45% Ni + 5% Cu	8,300				$\frac{1050}{1125 H_2}$	530	$5.5 \times 10^{-7}$
32	Sinimax	43% Ni + 3% Si	7,700				$\frac{1125 H_2}{1125 H_2}$		$8.5 \times 10^{-7}$
33	Monimax	48% Ni + 3% Mo	8,270				$\frac{1125 H_2}{1000 + 400}$	400	$8.0 \times 10^{-7}$
34	45-25 Perminvar	45% Ni + 25% Co						715	$1.9 \times 10^{-7}$

\* Notes appear on page 2-87.

TABLE 2.15 Properties of Soft Ferromagnetic Magnetic Materials (continued)

No.	Material	Description (Note 2)	Density $\rho_H$ , kg/m <sup>3</sup>	Thermal conduc- tivity $\lambda_0$ , W/(K m)	Coeffi- cient of linear thermal expansion, $\alpha_{4x}$ , $\times 10^6$ , (K) <sup>-1</sup>	Tensile strength, $S \times 10^{-8}$ , N/m <sup>2</sup>	Tensile modulus, $E_T$ , $\times 10^{-10}$ , N/m <sup>2</sup>	(Melt. temp.) (Anneal. temp.), °C (Note 3)	Curie temp., $T_C$ , °C (Note 4)	Resis- tivity $\rho$ , $\Omega$ m (Note 5)
35	Megaperm 6510	65% Ni + 10% Mn								$5.8 \times 10^{-7}$
36	7-70 Perminvar	70% Ni + 7% Co	8,600						650	$1.6 \times 10^{-7}$
37	Cr-Permalloy	78.5% Ni + 3.8% Cr	8,500					$1000 + 425$	420	$6.5 \times 10^{-7}$
38	4-79 Permalloy	79% Ni + 4% Mo	8,740			4.4	17.2	$1000$	460	$5.5 \times 10^{-7}$
39	Supermalloy	79% Ni + 5% Mo	8,770					$1100 H_2 + C$	400	$6.0 \times 10^{-7}$
40	Superperminvar	22.8% Co + 9% Ni						$1300 H_2 + C$		
41	Hiperco	35% Co + 0.5% Cr	8,000					Low temp.		
42	Vanadium Permendur	49% Co + 2% V	8,150	9.2		6.2	24.1	$1490$ $850$ $1485$ $840 N_2$	970 980	$2.0 \times 10^{-7}$ $4.0 \times 10^{-7}$
43	Mumetal	77% Ni + 5% Cu + 2% Cr	8,580	12.5		4.4	17.2	$1175 H_2 + C$	400	$6.2 \times 10^{-7}$
44	Superpermalloy	78.1% Ni + 2.9% Cr + 2.5% Sn								$6.1 \times 10^{-7}$
45	1040	72% Ni + 14% Cu + 3% Mo	8,760					$1100 H_2$	290	$5.6 \times 10^{-7}$

TABLE 2.15 Properties of Soft Ferromagnetic Magnetic Materials (continued)

No.	Initial relative permeability $\kappa_{mi}$ (Note 6)	Maximum relative permeability $\kappa_{m, max}$ (Note 6)	$H_0$ ( $H$ at $\mu_{max}$ ), A/m (Note 6)	$B_0$ ( $B$ at $\mu_{max}$ ), teslas (Note 6)	$H_s$ , A/m (Note 6)	$B_s$ , teslas (Note 6)	Reten- tivity $M_{res}$ , teslas (Note 6)	Coer- civity $H_{ci}$ , A/m (Note 6)	$-(B_d H_d)_{max}$ , J/m <sup>3</sup>	Ray- leigh con- stant $\eta_R$ , H/A	Stein- metz con- stant $\eta_s$ , J/(m <sup>3</sup> T <sup>2</sup> )	Stein- metz expo- nent $n$	Hys- teresis loop energy $W_h$ , J/m <sup>3</sup>
1	$1.0 \times 10^4$	[100] $2.9 \times 10^3$ [110] $2.1 \times 10^3$ [111] $1.8 \times 10^3$	5.5	[100] 1.97 [110] 1.45 [111] 1.22	[100] 13.5 [110] 47.8 [111] 43.8 $7 \times 10^4$	2.158	1.6	4	5.6	$3.14 \times 10^{-3}$	300	1.6	30
2	150	$5 \times 10^3$				2.15	0.72	79.5	500	$3.14 \times 10^{-3}$			500
3	120	$2 \times 10^3$	280	0.70		2.12		143		$3.14 \times 10^{-3}$			500
4	220	[111] 645 [110] 530 [100] 380	520	[111] 0.42 [110] 0.35 [100] 0.25	[111] $4 \times 10^3$ [110] $2 \times 10^4$ [100] $2.8 \times 10^4$	0.62	0.3	56		$3.90 \times 10^{-6}$			200
5	[0001] 70 [1010] 3	[0001] 250 [1010] 3	[0001] $4.8 \times 10^3$ [1010] $7.9 \times 10^4$	[0001] 1.5 [1010] 0.3	[0001] $1.5 \times 10^3$ [1010] $8.0 \times 10^3$	1.79		797		$1.62 \times 10^{-7}$			200
6	$1.5 \times 10^3$	$5.0 \times 10^4$	$1.43$	$1.09$	$1.95 \times 10^4$	2.00	1.5						
7	$1.5 \times 10^3$	$5.0 \times 10^4$	$1.43$	$1.09$	$1.95 \times 10^4$	2.00	1.5						
8	350	$4.7 \times 10^4$	$15.2$	$1.09$	$7.16 \times 10^3$	1.97	1.4		5.9				
9						2.01							
10	300	$7.2 \times 10^3$	71.5	0.63	$3.96 \times 10^4$	1.96	0.72	42	10.5	$2.4 \times 10^{-3}$			160
11	290	$6.6 \times 10^3$	79.6	0.66	$3.18 \times 10^4$	1.97	0.730	43	11.5				
12	290	$6.0 \times 10^3$	87.5	0.65	$3.42 \times 10^4$	1.98	0.735	43	11.5				
13	280	$5.5 \times 10^3$	119	0.82	$3.34 \times 10^4$	1.99	0.903	56	18.5				
14	280	$5.0 \times 10^3$	127	0.80	$3.74 \times 10^4$	2.03	0.880	72	21.0				
15		$6.7 \times 10^3$	107	0.90	$3.58 \times 10^4$	2.04	0.860	61	21.0				
16	200	$3.8 \times 10^3$	157	0.75	$5.0 \times 10^4$	2.00	0.95	600	1.4	$1.6 \times 10^3$			
17	500	$1.9 \times 10^4$	40	0.95		1.90		24					
18	700	$3.7 \times 10^3$				1.20		53					
19	$3.0 \times 10^3$	$5.5 \times 10^4$				0.80		3.2					150
20						0.20							
21	$2.5 \times 10^3$	$2.0 \times 10^4$				1.3		8					
22	$2.5 \times 10^3$	$2.5 \times 10^4$			$4.0 \times 10^3$	1.6		23.9		$2.52 \times 10^{-4}$			120
23	$4.0 \times 10^3$	$7.0 \times 10^4$	3.5	0.32		1.6	1.45	4.0					22
24	500	$1.5 \times 10^5$	3.4	0.53	800	1.55	0.95	5.5	8.2	$1.38 \times 10^{-3}$	13	1.77	33
25	90	100				1.60		480					
26	$8.0 \times 10^3$	$1.0 \times 10^5$				1.08		4.0					58
27	800	$5.0 \times 10^3$	480	1.2	$8.0 \times 10^3$	2.45	1.6	160					$1.2 \times 10^3$
28		$6.0 \times 10^3$	126	0.98	$3.3 \times 10^4$	2.07	1.17	60.5					426

TABLE 2.15 Properties of Soft Ferromagnetic Materials (concluded)

No.	Initial relative permeability $\kappa_{mi}$ (Note 6)	Maximum relative permeability $\kappa_{m, max}$ (Note 6)	$H_0$ (H at $\mu_{max}$ ), A/m (Note 6)	$B_0$ (B at $\mu_{max}$ ), teslas (Note 6)	$H_s$ , A/m (Note 6)	$B_s$ , teslas (Note 6)	Retentivity $M_{rs}$ , teslas (Note 6)	Coercivity $H_{cs}$ , A/m (Note 6)	$-(B_d H_d)_{max}$ , J/m <sup>3</sup>	Rayleigh constant $\eta_R$ , H/A	Steinmetz constant $\eta_s$ , J/(m <sup>3</sup> T <sup>n</sup> )	Steinmetz exponent $n$	Hysteresis loop energy $W_h$ , J/m <sup>3</sup>
29	$3.0 \times 10^4$	$1.2 \times 10^5$				1.00		4.0					10
30	60	65						478					
31	$2.0 \times 10^3$	$2.0 \times 10^4$				1.56	0.4	31.8					110
32	$3.0 \times 10^3$	$3.5 \times 10^4$	12.3	0.54		1.1	0.55	7.9					40
33	$2.0 \times 10^3$	$7.5 \times 10^4$	6.0	0.55		1.45	0.89	7.9				1.9	80
34	400	$2.0 \times 10^3$	320	0.8	$5.6 \times 10^3$	1.55		95.6		$1.6 \times 10^{-8}$	50		250
35	$4.8 \times 10^3$	$2.6 \times 10^4$	7.3	0.24		0.86		6.4					
36	850	$4.0 \times 10^3$				1.25		4.8					
37	$1.2 \times 10^4$	$6.2 \times 10^4$			800	0.80		4.0					
38	$2.0 \times 10^4$	$3.3 \times 10^5$	0.7	0.28	$1.4 \times 10^3$	0.87	0.65	4.0	2.08	$5.4 \times 10^{-3}$	17.6	1.8	20
39	$1.0 \times 10^3$	$1.0 \times 10^3$	0.32	0.40		0.79	0.45	0.16		0.188			0.8
40	63.5												
41	650	$1.0 \times 10^4$				2.42		80					330
42	800	$8.0 \times 10^3$	129	1.4	$8.0 \times 10^4$	2.4	2.14	25	56		224	3.6	600
43	$2.0 \times 10^4$	$2.9 \times 10^5$	0.64	0.24		0.65	0.32	4.0	1.42		44	1.9	4.0
44	$2.4 \times 10^4$	$8.0 \times 10^4$											
45	$4.0 \times 10^4$	$1.0 \times 10^5$	1.8	0.23	80	0.6	0.24	1.6					20

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**Magnetic moment** The relationship between a magnetic field and the torque exerted on a magnet, a current loop, or a charge that is moving in the field.

When a magnet is placed in a magnetic field of strength  $H$ , there is a torque  $L$  exerted on the magnet by the field. The torque is a maximum when the axis of the magnet is perpendicular to the field. The ratio of the torque for this position to the strength of the field is called the magnetic moment  $M$  of the magnet. See MAGNET.

If a flat coil of wire of  $N$  turns and area  $A$ , in which there is a current  $I$ , is placed in a magnetic field of flux density  $B$ , the coil experiences a torque  $L$  given by Eq. (1), where  $\theta$  is the

$$L = NIAB \sin \theta \quad (1)$$

angle between the field and the normal to the plane of the coil. The torque is maximum when  $\theta = 90^\circ$ , that is, when the plane of the coil is parallel to the field. The ratio of the maximum torque to the flux density  $B$  is the magnetic moment of the coil, as shown in Eq. (2). If a charge is spinning, there is a

$$M = \frac{L}{B} = NIA \quad (2)$$

charge in motion and thus an electric current. The spin is equivalent to a tiny current loop which has a magnetic moment. Atomic nuclei also possess magnetic moments. See ELECTRON MAGNETIC MOMENT; ELECTRON SPIN; NUCLEAR MOMENTS.

[K.V.M.]

# **Magnetic Disk Drive Technology**

*Heads, Media,  
Channel,  
Interfaces,  
and Integration*

**Kanu G. Ashar**

*With contributions by  
Roger F. Hoyt  
Kenneth E. Johnson  
James C. Suits*

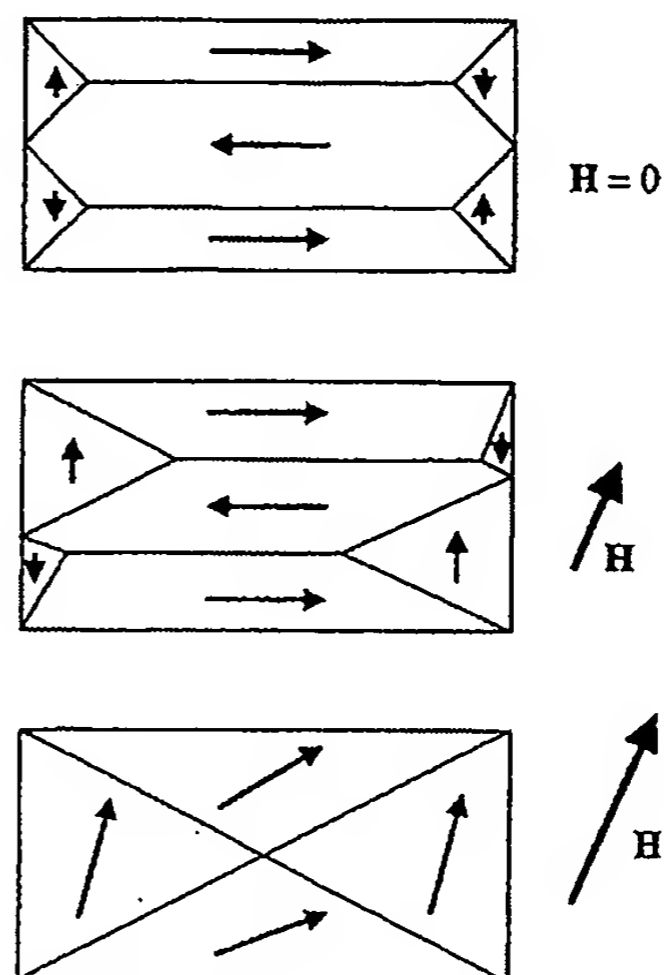


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## 2.15 DOMAINS

Now that we understand anisotropy, we can discuss the hysteresis loop behavior in more detail. A typical magnetic material will in general consist of many *magnetic domains*. A *domain* is a local region of the material in which all atomic moments are pointing in the same direction. However, the moment in one domain will not be parallel to the moment in a neighboring domain. For example, in the upper part of Figure 2.19 we show the directions of magnetization in a rectangular slab of material.



**Figure 2.19** Wall motion and domain rotation under application of an external magnetic field.

Each arrow shows the magnetization direction in a particular domain. The lines between domains represent *domain walls*. These walls are very narrow regions—in iron, they are approximately 100 nm (1000 Å) thick—in which the magnetization changes from its direction in one domain to its direction in the adjacent domain. Thus, the magnetization in a magnetic material does not change directions gradually over large distances. The changes in magnetization direction are confined to the very small volume of the material consisting of domain walls.

We have assumed in Figure 2.19 that this material has a uniaxial anisotropy with a horizontal easy axis. Why is not all the magnetization in this figure directed horizontally? The pattern of domains in the top of Figure 2.19 is a particular arrangement that minimizes demagnetizing energy. We saw in our earlier discussion of demagnetizing fields that when the magnetic moment is pointing toward a boundary where the magnetization changes, such as at the edge of the sample, uncompensated magnetic poles appear. These poles create a magnetic field, and this field contains energy. To reduce the demagnetizing energy, the domains try to

arrange themselves in such a way as to reduce the number of these poles. In this figure, we note that at all edges of the sample, the magnetization is parallel to the edge. Therefore, no poles are created at the edges. We also note that all magnetization vectors intersect domain walls at the same angle ( $45^\circ$ ). Thus, the perpendicular components of magnetization on entering and leaving a domain wall are equal, and so there is no net magnetic charge built up at a domain wall. The particular magnetization configuration shown in the figure results in no magnetostatic energy being created by demagnetizing poles on surfaces or on domain walls. Therefore, it is a low-energy configuration.

If a field is applied as shown in the figure, the domain magnetization tries to line up with the field (like the dipole in Fig. 2.7). The first thing that happens is the domain walls begin to move. With very small fields, domains may move reversibly since they sit in small potential wells. This reversible region is shown as the  $0-a$  section on the initial hysteresis loop of Figure 2.13. At higher applied fields, as in the middle panel of Figure 2.19, the domains move irreversibly in such a way as to enlarge the domains that are favorably oriented with respect to the field and diminish the domains that are unfavorably oriented. This corresponds to the section  $a-b$  on the initial hysteresis curve of Figure 2.13. Finally, at large fields, rotation of the domains occurs and domain rotation is reversible (section  $b-c$  of Fig. 2.13). At a still higher field, all the magnetization points in the field direction, there are no more domain walls, and the sample is said to be saturated ( $M = M_s$  in Fig. 2.13).

How much magnetization switching is due to wall motion and how much is due to domain rotation depends upon the field orientation. If  $\mathbf{H}$  is oriented parallel to the easy axis direction, the sample switches entirely by wall motion. If  $\mathbf{H}$  is oriented perpendicular to the easy axis, the sample switches entirely by domain rotation. For intermediate fields, the sample switches by a combination of wall motion and domain rotation.

## 2.16 EXCHANGE

We have discussed that in certain materials like iron and nickel, atomic magnetic dipoles tend to line up with each other to produce an overall magnetization for the material. Materials in which adjacent dipole moments tend to line up in the same direction are called *ferromagnetic*. The occurrence of ferromagnetism is relatively rare—looking at the periodic table, we see that only a few of the pure elements (iron, nickel, cobalt, and gadolinium; see Table 2.1) exhibit ferromagnetism at room temperature. Without this tendency for atomic dipoles to line up parallel to each other, we would not have magnetic recordings, or electric motors, or many of the devices to which we have grown accustomed.

The tendency for neighboring atomic dipoles to line up parallel or antiparallel to each other is called *exchange*. The detailed description of exchange can be given only in terms of quantum mechanics. Basically, exchange results from the overlap of orbiting electrons on adjacent atoms. The atomic moment of an atom is

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**gauss** (*Phys*) CGS electromagnetic unit of magnetic flux density; equal to  $1 \text{ maxwell cm}^{-2}$ , each unit magnetic pole terminating  $4\pi$  lines. Now replaced by the SI unit of magnetic flux density, the tesla (T).  $1 \text{ T} = 10^4 \text{ gauss}$ .

**oersted** (*Phys*) CGS electromagnetic unit of magnetic field strength, such that  $2\pi$  oersted is a field at the centre of a circular coil one centimetre in radius carrying a current of one abampere (10 A). Now replaced by the SI unit  $\text{A m}^{-1}$ .  $1 \text{ A m}^{-1} = 4\pi \times 10^{-3} \text{ oersted}$ .

**tesla** (*Phys*) SI unit of magnetic flux density or magnetic induction equal to  $1 \text{ weber m}^{-2}$ . Equivalently, the magnetic induction for which the maximum force it produces on a current of unit strength is 1 N. Symbol T.

**B. D. CULLITY**  
University of Notre Dame

# INTRODUCTION TO MAGNETIC MATERIALS

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## INDUCED MAGNETIC ANISOTROPY

### 10.1 INTRODUCTION

So far in this book we have encountered three kinds of magnetic anisotropy: crystal, shape, and stress. Various other kinds may be induced in certain materials, chiefly solid solutions, by appropriate treatments. These induced anisotropies are of considerable interest both to the physicist, for the light they throw on basic magnetic phenomena, and to the technologist, who may wish to exploit them in the design of magnetic materials for specific applications.

The following treatments can induce magnetic anisotropy:

1. *Magnetic annealing.* This means heat treatment in a magnetic field, sometimes called a *thermomagnetic* treatment. This treatment can induce anisotropy in certain alloys. (Here the term "alloys" includes not only metallic alloys but also mixed ferrites.) The results depend on the kind of alloy:
  - a) Two-phase alloys. Here the cause of anisotropy is the shape anisotropy of one of the phases and is therefore not basically new. However, it is industrially important because it affects the behavior of some of the Alnico permanent-magnet alloys. It will be described in Chapter 14.
  - b) Single-phase solid-solution alloys. Here it will be convenient to discuss substitutional and interstitial alloys in separate sections.
2. *Stress annealing.* This means heat treatment of a material that is simultaneously subjected to an applied stress.
3. *Plastic deformation.* This can cause anisotropy both in solid solutions and in pure metals, but by quite different mechanisms.
4. *Magnetic irradiation.* This means irradiation with high-energy particles in a magnetic field.

### 10.2 MAGNETIC ANNEALING (SUBSTITUTIONAL SOLID SOLUTIONS)

When certain alloys are heat treated in a magnetic field and then cooled to room temperature, they develop a permanent uniaxial anisotropy with the easy axis parallel to the direction of the field during heat treatment. They are then magnetically softer along this axis than they were before treatment. The heat treat-

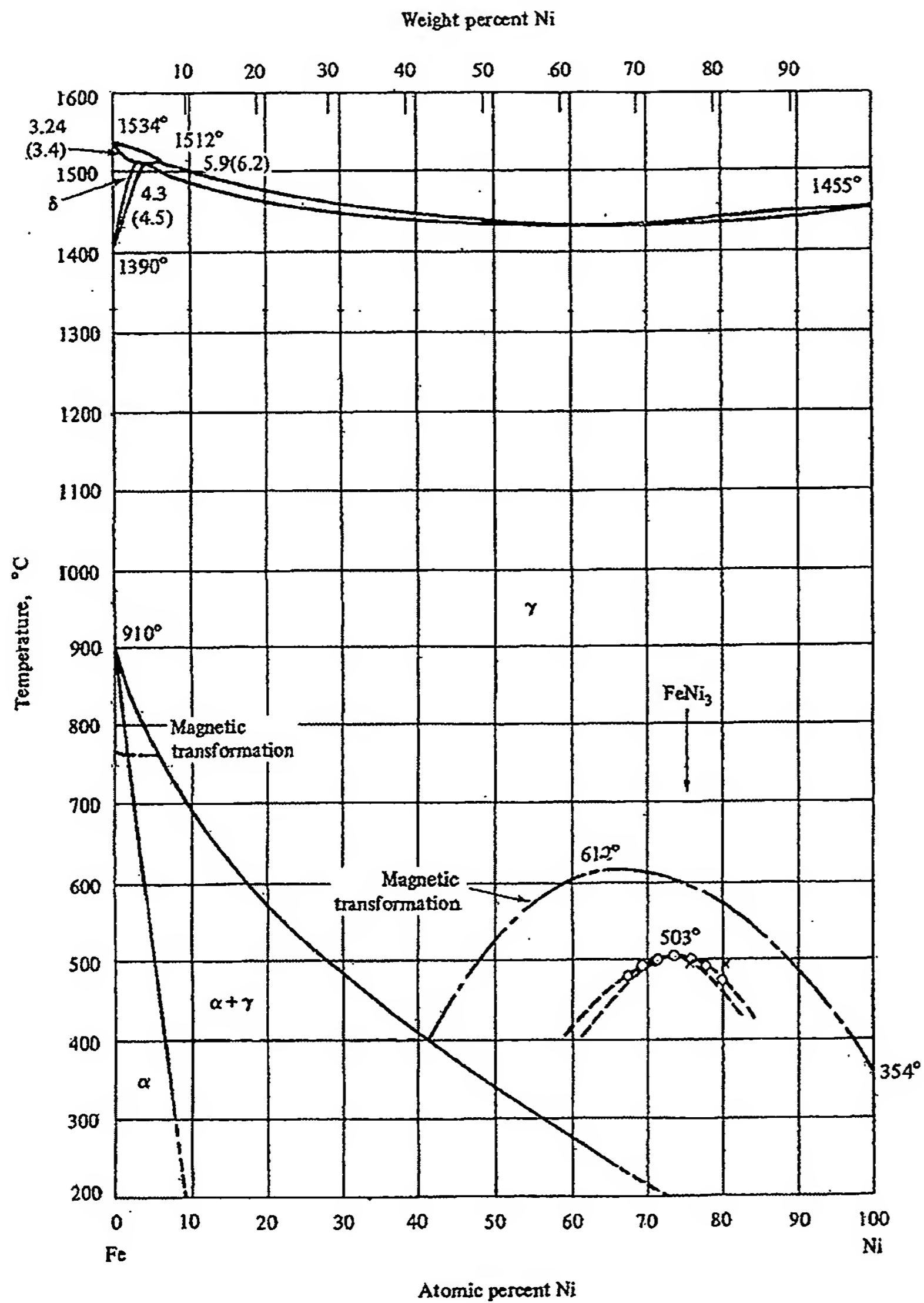


Fig. 10.1 Equilibrium diagram of Fe-Ni alloys. Hansen and Anderko [10.6].

ment may consist only of cooling through a certain temperature range in a field, rather than prolonged annealing; the cooling range or annealing temperature must be below the Curie point of the material and yet high enough, usually above

400 C, so that substantial atomic diffusion can occur. An alternating or unidirectional field is equally effective; all the field does is determine an easy axis, rather than direction, of easy magnetization. The field must be large enough to saturate the specimen during the magnetic anneal, if the resulting anisotropy is to develop to its maximum extent. Usually a field of some 10 Oe or less is sufficient; the material is magnetically soft to begin with, and its permeability at the magnetic-annealing temperature is higher than at room temperature. The term "magnetic annealing" is applied both to the treatment itself and to the phenomenon which occurs during the treatment; i.e., an alloy is often said to magnetically anneal if it develops a magnetic anisotropy during such an anneal. The subject of magnetic annealing has been reviewed by Graham [10.1], Slonczewski [10.2], and Chikazumi and Graham [10.3]; Graham's review contains a large bibliography classified by material composition.

The phenomenon of magnetic annealing was first discovered in 1913 by Pender and Jones [10.4] in an alloy of Fe + 3.5 percent Si. They found that cooling the alloy from about 800°C to room temperature in an alternating field, of about 20 Oe maximum value, caused a substantial increase in maximum permeability. Many years later Goertz [10.5] made measurements on a picture-frame single crystal, with  $\langle 100 \rangle$  sides, of an alloy of Fe + 6.5 percent Si; heat treatment in a field increased its maximum permeability from 50,000 to  $3.8 \times 10^6$ , the highest value yet reported for any material.

However, most of the research on magnetic annealing has been devoted to the binary and ternary alloys of Fe, Co, and Ni. Compositions which respond well to magnetic annealing are Fe + 65–85 percent Ni, Co + 30–85 percent Ni, Fe + 45–60 percent Co, and the ternary alloys containing 20–60 percent Ni, 15–35 percent Fe, balance Co. Magnetic annealing has been studied most often in binary Fe-Ni alloys, for which the equilibrium diagram is shown in Fig. 10.1. Both the  $\alpha$  (body-centered cubic) and the  $\gamma$  (face-centered cubic) phases are ferromagnetic. There is a large thermal hysteresis in the  $\alpha \rightarrow \gamma$  and  $\gamma \rightarrow \alpha$  transformations because of low diffusion rates below about 500 C, and the equilibrium shown in Fig. 10.1 is very difficult to achieve. For example, the  $\gamma \rightarrow \alpha$  transformation on cooling is so sluggish that it is easy to obtain 100 percent  $\gamma$  at room temperature in alloys containing more than about 35 percent Ni by air cooling  $\gamma$  from an elevated temperature. Hansen and Anderko [10.6] should be consulted for further details.

Typical of the magnetic-annealing results obtained on Fe-Ni alloys are those shown for 65 Permalloy in Fig. 10.2. Comparison of the hysteresis loop of (c) with (a) or (b) shows the dramatic effect of field annealing: the sides of the loop become essentially vertical, as expected for a material with a single easy axis. Conversely, if the loop is measured parallel to the hard axis, i.e., at right angles to the annealing field, the sheared-over, almost linear loop shown in (d) is obtained, where the change in the  $H$  scale should be noted. [Specimens for magnetic annealing studies are sometimes in the form of rods, either straight or made into a hollow rectangle in order to have a closed magnetic circuit. In any case it is not usually practical to apply a field transverse to the rod axis because of the very large demagnetizing factor, equal to  $2\pi$ , in that direction. Instead, a direct cur-

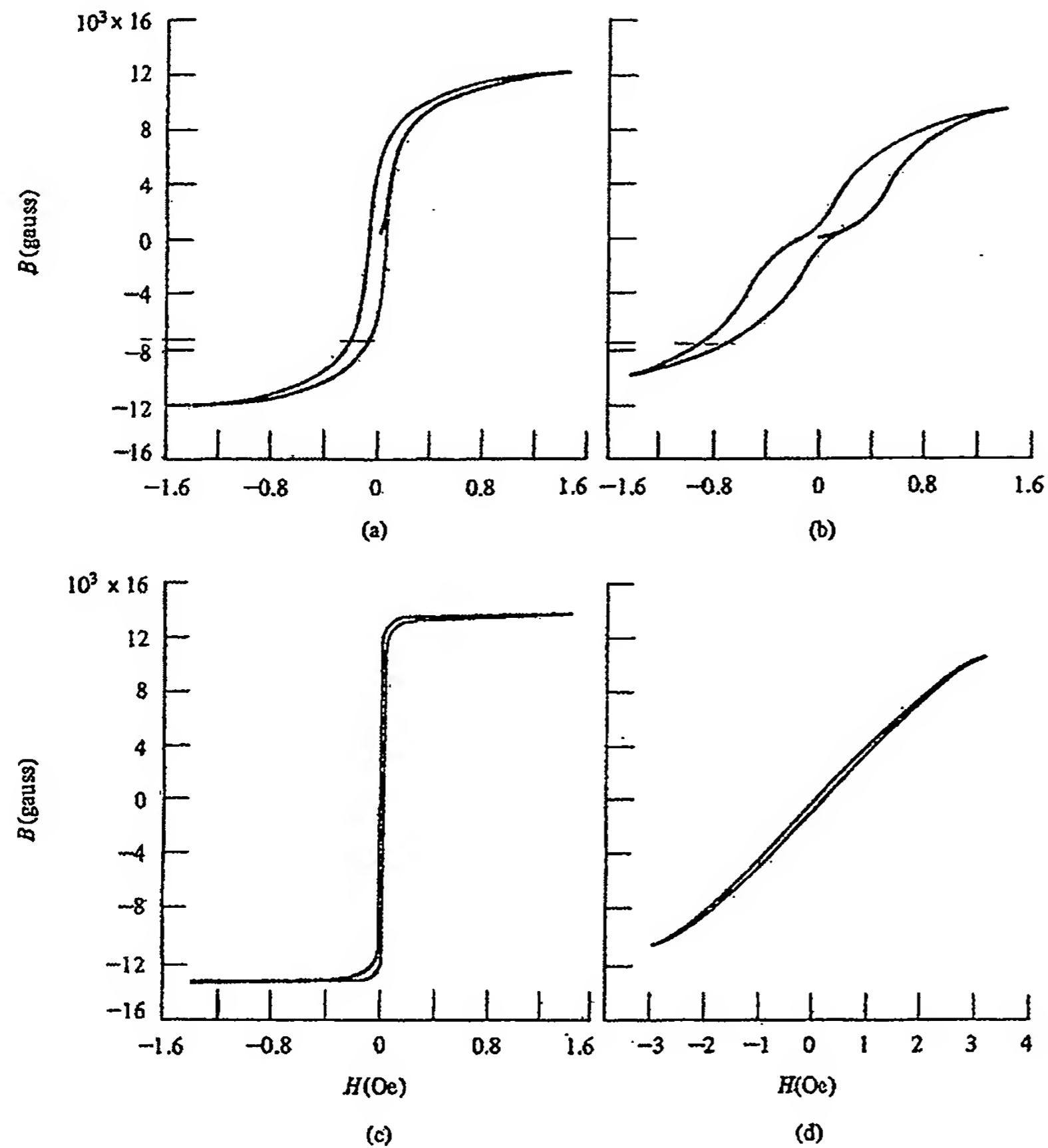


Fig. 10.2 Hysteresis loops of a 65 Ni-35 Fe alloy after various heat treatments: (a) annealed at 1000°C and cooled quickly, (b) annealed at 425°C or cooled slowly from 1000°C, (c) annealed at 1000°C and cooled in a longitudinal field; (d) same as (c) but with a transverse field. Bozorth [G.4].

rent is passed along the rod axis during the anneal, producing a circular field around the axis (Section 1.6). This field can easily be made strong enough to saturate the specimen circumferentially, except for a relatively small volume near the axis. If a magnetic measurement is subsequently made parallel to the axis in the usual way, the measurement direction is then at right angles to that of the annealing field. A longitudinal annealing field is achieved simply by wrapping the rod with a helical magnetizing winding, suitably protected by an insulator that will withstand the annealing temperature. If the specimen is in the form

**In re Glaug**

U.S. Court of Appeals  
Federal Circuit

No. 00-1571

Decided March 15, 2002

**PATENTS**

**[1] Patentability/Validity — Obviousness  
— Relevant prior art — Particular in-  
ventions (§ 115.0903.03)**

**Patent construction — Claims — Defin-  
ing terms (§ 125.1305)**

General term used to introduce concept that is further defined more narrowly must be understood in context in which inventor presents it; in present case, use of term "intermittent" in specification of prior patent for disposable training pants does not suggest use of zones entirely free of adhesive holding elastic to fabric required by claims of application at issue, since specification of prior patent makes clear that process claimed therein requires broad contact between elastic and adhesive, with illustrations of continuous zones of adhesive that fix fabric to elastic, whereas applicant's specification uses "intermittent" to designate only distinct zones of adhesive spaced apart by zones free of adhesive.

**[2] Patentability/Validity — Obviousness  
— Evidence of (§ 115.0906)**

Comparative data in specification of application for method of making disposable training pants, showing that elastic in pants made by claimed process exhibited less than half decay in elasticity as compared to seven commercial brands of training pants, are relevant evidence of non-obviousness, since data are offered as being illustrative of advantageous property of training pants made by claimed process as measured by rate of elastic decay; although measurement of physical property may not of itself impart patentability to otherwise unpatentable claims, measurement that serves to point up distinction from prior art, or advantages over prior art, is relevant to patentability.

**[3] Patentability/Validity — Obviousness  
— Evidence of (§ 115.0906)**

Inventor's explanation of how claimed invention works does not render obvious that which is otherwise unobvious; in present case, prior art does not show use of spaced zones of adhesive holding elastic to fabric claimed in application for method of making disposable training pants, and applicant's teaching that use of such spaced zones permits fabric to bunch and stretch therefore is not evidence of obviousness, and if anything, supports unobviousness of discovery that spacing adhesive reduces elastic decay.

Appeal from the U.S. Patent and Trademark Office, Board of Patent Appeals and Interferences.

Patent application of Frank S. Glaug and Margaret A. Kato (serial no. 08/455,374). Applicants appeal from decision upholding patent examiner's rejection of all claims in application. Reversed.

Meredith Martin Addy, Robert N. Carpenter, and Henry L. Brinks, of Brinks, Hofer, Gilson & Lione, Chicago, Ill., for appellants.

Linda Moncys Isacson, associate solicitor; John M. Whealan, solicitor; Mary Critharis, associate solicitor, U.S. Patent and Trademark Office, Arlington, Va., for appellee.

Before Mayer, chief judge, and Newman and Michel, circuit judges.

**Newman, J.**

Frank S. Glaug and Margaret A. Kato (herein "Glaug") appeal the decision of the Board of Patent Appeals and Interferences of the United States Patent and Trademark Office, rejecting all of the claims of patent application Serial No. 08/455,374 entitled "Process for Making a Training Pant Having a Unitary Waist Elastic System." The Board's decision is reversed.

The Glaug invention is a method of making disposable training pants. The pants are described as providing a more comfortable fit over a wider weight and size range as well as a longer useful life, as compared with known training pants, because the elasticity at the waist is preserved over a longer period of repeated cycles of elastic extension and contraction, such as when the child lowers and raises the pants. These benefits result from the manner in which the elastic is adhered at the waist,

achieved by placing the adhesive that holds the elastic in spaced zones so that there are zones wherein the fabric is unadhered between the adhesive zones, and folding the edge of the fabric over the elastic. Claim 1, the broadest claim, is representative. Emphases have been added to the features asserted by Glaug to provide distinction from prior art processes:

1. A process having a machine direction and a cross direction for making disposable absorbent articles, comprising the steps of:

[a] continuously moving a base layer generally in a machine direction, the base layer comprising opposite edge portions generally extending in the machine direction,

[b] providing a plurality of absorbent structures having respective length dimensions greater than respective width dimensions,

[c] positioning the absorbent structure at spaced apart locations between the opposite edge portions of the base layer, such that the length dimensions of the absorbent structure are generally transverse to the machine direction,

[d] applying an adhesive, generally in the machine direction, at *selected spaced apart zones of each edge portion, the zones of each edge portion being spaced apart in the machine direction,*

[e] continuously delivering an elastic member generally in the machine direction onto each edge portion,

[f] *folding each edge portion, generally in a cross direction, over the respective elastic member,*

[g] joining together each folded edge portion and the elastic member,

[h] folding the continuously moving base layer along a fold line generally parallel to the machine direction, and

[i] forming a plurality of disposable absorbent articles having a respective plurality of closed-loop waist-elastic systems in which each waist elastic system has an *average maximum magnitude of decay less than about 66.67 grams in an extension range of about 175 millimeters to about 300 millimeters over the first three cycles.*

The placement of the adhesive is illustrated in the following diagram of the construction process:

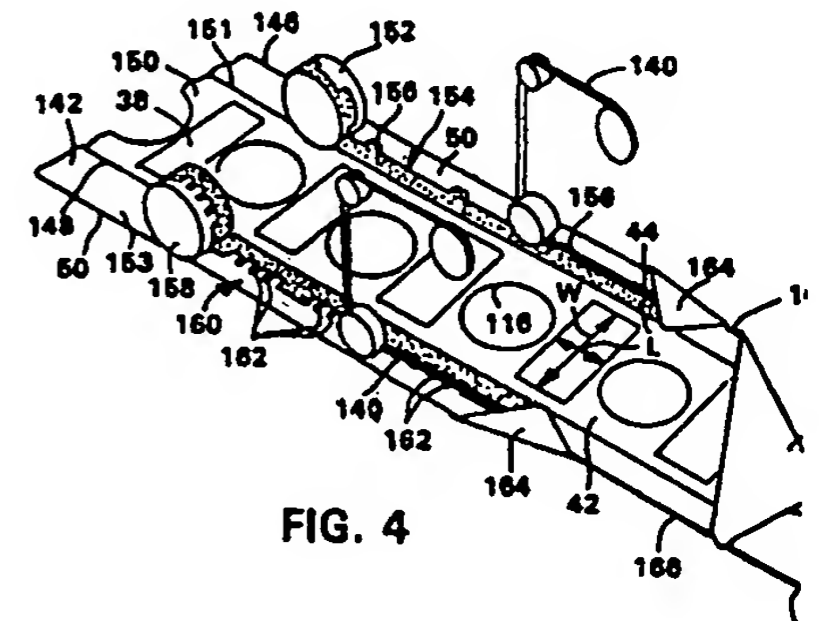


FIG. 4

Figure 4 shows a process for making one embodiment of the pant. As base layer 142 is continuously moved through the machine, absorbent structures 38 are attached and leg openings 116 are cut. To form the waist elastic system, adhesive is applied by means of patterned adhesive rolls 152 and 158. Glaug explains that different adhesive patterns are shown on rolls 152 and 158 to illustrate different possible patterns, but that generally the patterns are the same on both sides of the base layer. The adhesive 154 is thus applied in a pattern, which includes a plurality of distinct adhesive zones 156 and 162 which are spaced apart from one another. An elongate elastic member 140 is joined to the adhesive zones 156 and 162. The remaining adhesive, as at 154, serves to join the folded-over edge of the base layer 142 after it passes folding boards 164. The structure is then folded down its center, cut at the leg openings, and sealed to form pants.

#### The PTO Proceedings

During patent examination the PTO bears the initial burden of presenting a *prima facie* case of unpatentability. *In re Oetiker*, 977 F.2d 1443, 1445, 24 USPQ2d 1443, 1444 (Fed. Cir. 1992); *In re Piasecki*, 745 F.2d 1468, 1472, 223 USPQ 785, 788 (Fed. Cir. 1984). If the PTO fails to meet this burden, then the applicant is entitled to the patent. However, when a *prima facie* case is made, the burden shifts to the applicant to come forward with evidence and/or argument supporting patentability. Patentability *vel non* is then determined on the entirety of the record, by a preponderance of evidence and weight of argument. *Id.* As discussed in *In re Rinehart*, 531 F.2d 1048, 1052,

189 USPQ 143, 147 (CCPA 1976), the *prima facie* case is not a stone wall against which rebuttal evidence is tested; patentability is determined by a preponderance of all the evidence. We review the Board's decision on the record, in accordance with the appellate criteria of the Administrative Procedure Act, 5 U.S.C. § 706. See *Dickinson v. Zurko*, 527 U.S. 150, 50 USPQ2d 1930 (1999).

The examiner rejected all of the claims on the ground of obviousness, based on United States Patent No. 5,147,487 (Nomura) in view of United States Patent No. 3,225,765 (Magid). Both references relate to disposable baby pants. The Nomura reference shows a method having the steps of Glaug's claim 1 except for those shown *supra* in bold face [italics]. Magid shows a fold or hem of fabric over the elastic at the waist and legs of baby pants. The Board found that Nomura suggested "intermittent" spacing of the adhesive for the elastic waist, that the numerical magnitude of elastic decay as stated in claim 1 is inherent in the Glaug structure and thus not of patentable significance, and that it would have been obvious to place the Magid hem over the Nomura elastic. The Board held that a *prima facie* case of obviousness was made, and that Glaug's evidence of superior results was inadequate to rebut that conclusion.

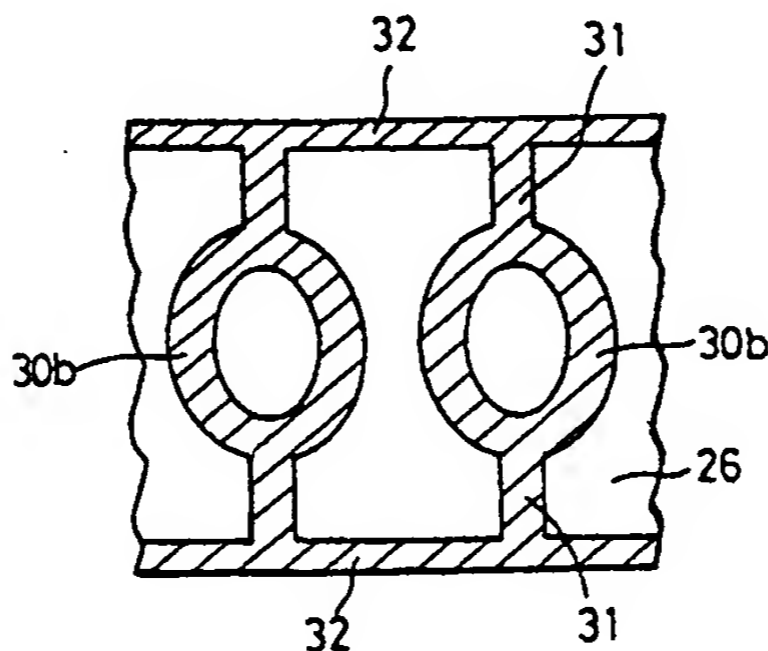
#### Claim Clause [d] - The Spaced Apart Adhesive Zones

Claim clause [d] states that the adhesive is applied "generally in the machine direction" in "zones" that are "spaced apart." The specification explains that the adhesive may be placed only on the seams with the elastic secured when the halves of the folded-over pant are joined together, or may be spaced more closely along the elastic with as little as half-inch gaps between zones of adhesive. Nomura describes and illustrates, in the preferred embodiments, applying the adhesive to the pant edges in a continuous film. Nomura also states that "the adhesive zones may be applied with adhesive continuously extending overall on these zones, or in a plurality of dots, intermittent lines, or helical lines."

The Board held that this was a *prima facie* teaching of Glaug's "spaced apart" adhesive zones, in that Glaug's placement of adhesive in zones is taught by or would have been obvious from the Nomura reference. The Board pointed out that both Nomura and Glaug use

the word "intermittent" in describing the adhesive.

Glaug argues that Nomura's illustrations do not show intermittent zones of adhesive, and that the only usage of "intermittent" by Nomura is in one broad catch-all sentence at the end of the description. Glaug argues that Nomura clearly did not contemplate spaced zone-type gaps in the adhesive placement in the machine direction. Glaug points to the following illustration from Nomura, and argues that Nomura does not show adhesive placed in zones that are separated by adhesive-free zones:



In Nomura, the pants are formed by spreading adhesive upon a continuous web 26, formed of fibrous non-woven fabric, introducing elastic members (not shown) and bonding the arrangement to another continuous web, sandwiching absorbent material within. The diagram reproduced shows the placement of adhesive at 30b around the leg openings, at 32 along the waist, and at 31 extending from opposite sides of adhesive 30b to the adjacent lateral edges of the web 26.

Glaug also points out that Nomura adheres the elastic in an entirely different way from the Glaug process: Nomura stretches the elastic, and applies the adhesive to the fabric in a broad band in order to hold the elastic in the stretched position during the manufacturing process. Glaug points out that the Nomura adhesive must be placed so that it provides a large surface area and continuous attachment between the elastic and the fabric. In contrast, the Glaug specification is explicit that the adhesive is applied so as to reduce the area of attachment between the elastic and the fabric, so that zones of fabric are not adhered to the

elastic and can bunch or stretch between the points of adhesion.

[1] Glaug is correct that the Nomura usage of "intermittent" does not suggest the presence of zones entirely free of adhesive and disposed generally in the machine direction. Nomura's specification makes clear that his process requires broad contact between the elastic and the adhesive, with illustrations of continuous zones of adhesive that fix the fabric to the stretch elastic. In contrast, Glaug's specification uses "intermittent" to designate only distinct zones of adhesive spaced apart by zones free of adhesive. Typical descriptions from Glaug's specification are:

The intermittent pattern of joining is a pattern of 1.27 centimeter (0.5 inch) wide adhesive zones separated by 1.27 centimeter wide zones with no adhesive. [Application p. 31.]

[P]ulsed adhesive system 90 can apply an adhesive pattern such as an adhesive zone 92 (Fig. 5) having a window 93 that is void of adhesive. [Application p. 42.]

Adhesive pattern 154 includes a plurality of distinct adhesive zones 156 which are spaced apart from one another, i.e., intermittently applied, in the machine direction 144. [Application pp. 48-49.]

Patterned adhesive roll 158 applies an optional adhesive pattern 160 having a plurality of spaced-apart distinct adhesive zones 162. [Application p. 49.]

The Solicitor cites Glaug's statement that the adhesive roll applies adhesive "intermittently . . . in [the] machine direction [to include] a plurality of distinct adhesive zones 156 which are spaced apart from one another, i.e., intermittently applied," as showing that Glaug himself taught that "spaced apart" and "intermittent" have the same meaning. Glaug responds that his meaning of "intermittent" is as described in the specification, which defines what Glaug meant. Glaug states that "intermittent," in his method, means that the adhesive zones are separated by zones of no adhesive, and thus is distinguished from overlapping strips of adhesive as found in Nomura. Although the Solicitor states that "Nomura expressly teaches 'applying an adhesive' in 'spaced apart zones,'" PTO brief at 14, these words are quoted from Glaug, not Nomura.

It is well established that when a general term is used to introduce a concept that is further defined more narrowly, the general term must be understood in the context in which the inventor presents it. *Multiform Desiccants Inc. v. Medzam, Ltd.*, 133 F.3d 1473, 1477, 4: USPQ2d 1429, 1432 (Fed. Cir. 1998) ("This rule of construction recognizes that the inventor may have imparted a special meaning to term in order to convey a character or property or nuance relevant to the particular invention.") The word "intermittent" is susceptible of various meanings, and the inventor's lexicography must prevail, *Intellicall, Inc. v. Phonometrics, Inc.*, 952 F.2d 1384, 1388, 2: USPQ2d 1383, 1387 (Fed. Cir. 1992); *Lea Siegler, Inc. v. Aeroquip Corp.*, 733 F.2d 881, 889, 221 USPQ 1025, 1031 (Fed. Cir. 1984).

The Solicitor states that Glaug did not argue before the Board that Nomura does not show "spaced apart zones," and that Glaug must therefore be prohibited from raising this argument before the Federal Circuit. Glaug responds, and the record shows, that he argued to the Board that "the references teach different structures." The issue of the adhesive structure was before the Board, whose familiarity with the content of the application and the references on which it relies may be assumed by the patent applicant, and need not be repeated as if on appeal to a non-technical court. An applicant's arguments to the PT examiner and Board are not normally presented in the identical phrases and elaborative lengths that are usually needed in an appeal to the court. It is apparent that the different structures of Glaug's invention and those of the Nomura reference were at issue and were argued before the Board. We thus agree with Glaug that the Nomura reference does not present a *prima facie* case of obviousness in the placement of the adhesive in Glaug's process.

#### *Claim Clause [i] - The Decay Parameters*

[2] Glaug tabulated, in his specific comparative data of elastic decay using his system of adhesive zones, as compared with seven commercial brands of training panels. These data showed that the elastic in the panels made by his process exhibited less than half the decay in elasticity, compared with the best of seven commercial brands of training panels. The Board rejected this evidence because

Glaug did not describe how the elastic waist was constructed in these prior art pants. The Solicitor argues that these comparative data are not of sufficient quality to overcome the *prima facie* case of obviousness made by the prior art. On its face, Glaug's data show improvement over these commercial products. These data, included in the specification, are not offered as rebuttal evidence, but as illustrative of an advantageous property of Glaug's training pant as measured by the rate of elastic decay.

Nomura does not suggest that elastic decay would be reduced by spaced placement of the adhesive to provide adhesive-free zones. Thus, Glaug argues, the claim limitation "in which each waist elastic system has an average maximum magnitude of decay less than about 66.67 grams in an extension range of about 175 millimeters to about 300 millimeters over the first three cycles" is neither taught nor suggested by Nomura.

The Board held that the numerical measure of elastic decay in the Glaug claims is simply inherent in any improvement achieved by Glaug through the placement of his adhesive, and does not impart patentability to the claims. While the measurement of a physical property may not of itself impart patentability to otherwise unpatentable claims, when the measured property serves to point up the distinction from the prior art, or advantages over the prior art, that property is relevant to patentability, and its numerical parameters can not only add precision to the claims but also may be considered, along with all of the evidence, in determination of patentability. See *Pall Corp. v. Micron Separations, Inc.*, 66 F.3d 1211, 1216, 36 USPQ2d 1225, 1228 (Fed. Cir. 1995) (affirming the district court's definition of "skinless" as a performance characteristic in accordance with the measurements of bubble point, flow time, and KL curve); *In re Soni*, 54 F.3d 746, 750, 34 USPQ2d 1684, 1687 (Fed. Cir. 1995) ("One way for a patent applicant to rebut a *prima facie* case of obviousness is to make a showing of 'unexpected results,' i.e., to show that the claimed invention exhibits some superior property or advantage that a person of ordinary skill in the relevant art would have found surprising or unexpected.")

#### The Technical Explanation

Glaug explained in the specification that his use of spaced adhesive zones "reduc[es] the

surface area of joinder between the elastic member and the layer of material [with] a resultant reduction in the elastic member's loss of elasticity." [Application, p.9] The Board stated, and the Solicitor argues, that Glaug's technical explanation of how his invention works establishes that any "intermittently spaced" adhesive would inherently achieve the benefits of the invention. The Board held that this renders the claims obvious because "according to appellants' above-quoted disclosure, this reduction in the surface area of joinder would inherently cause a reduction in the loss of elasticity (decay) of the Nomura elastic members." Bd. op. at 5. Glaug complains that the Board used Glaug's own explanation of his invention against him, instead of citing evidence from the prior art.

[3] An inventor's explanation of how the invention works does not render obvious that which is otherwise unobvious. Since the prior art does not show the spaced zones of adhesive that are provided by Glaug, his teaching that the spacing permits the fabric to bunch and stretch is not evidence of obviousness. If anything, this teaching supports the unobviousness of Glaug's discovery that spacing the adhesive reduces elastic decay so that the magnitude of decay is as stated in claim clause [i].

#### Conclusion

The material facts are generally undisputed. On the entirety of the record we conclude, as a matter of law, that the placement of the adhesive in spaced apart zones generally in the machine direction would not have been obvious in view of Nomura. See *Graham v. John Deere*, 383 U.S. 1, 17, 148 USPQ 459, 467 (1966) (obviousness is a question of law based on underlying facts).

#### Claim Clause [f] - The Folded Edge Over the Elastic

The Magid reference describes a tubular edging of fabric on baby pants to reduce skin irritation. The Board found that this constitutes a folded "hem" which would obviously increase the strength of the edge, and ruled that it would for this reason have been obvious to fold the edge over the elastic of the Glaug training pant.

Glaug states that increased strength of a hem is irrelevant to his process, and points out that Magid does not relate to the adhesive

placement. In view of our conclusion that Glaug's adhesive placement establishes patentability of claim 1, we need not consider the effect of the Magid reference.

The decision of the Board is reversed.<sup>1</sup>

*REVERSED*

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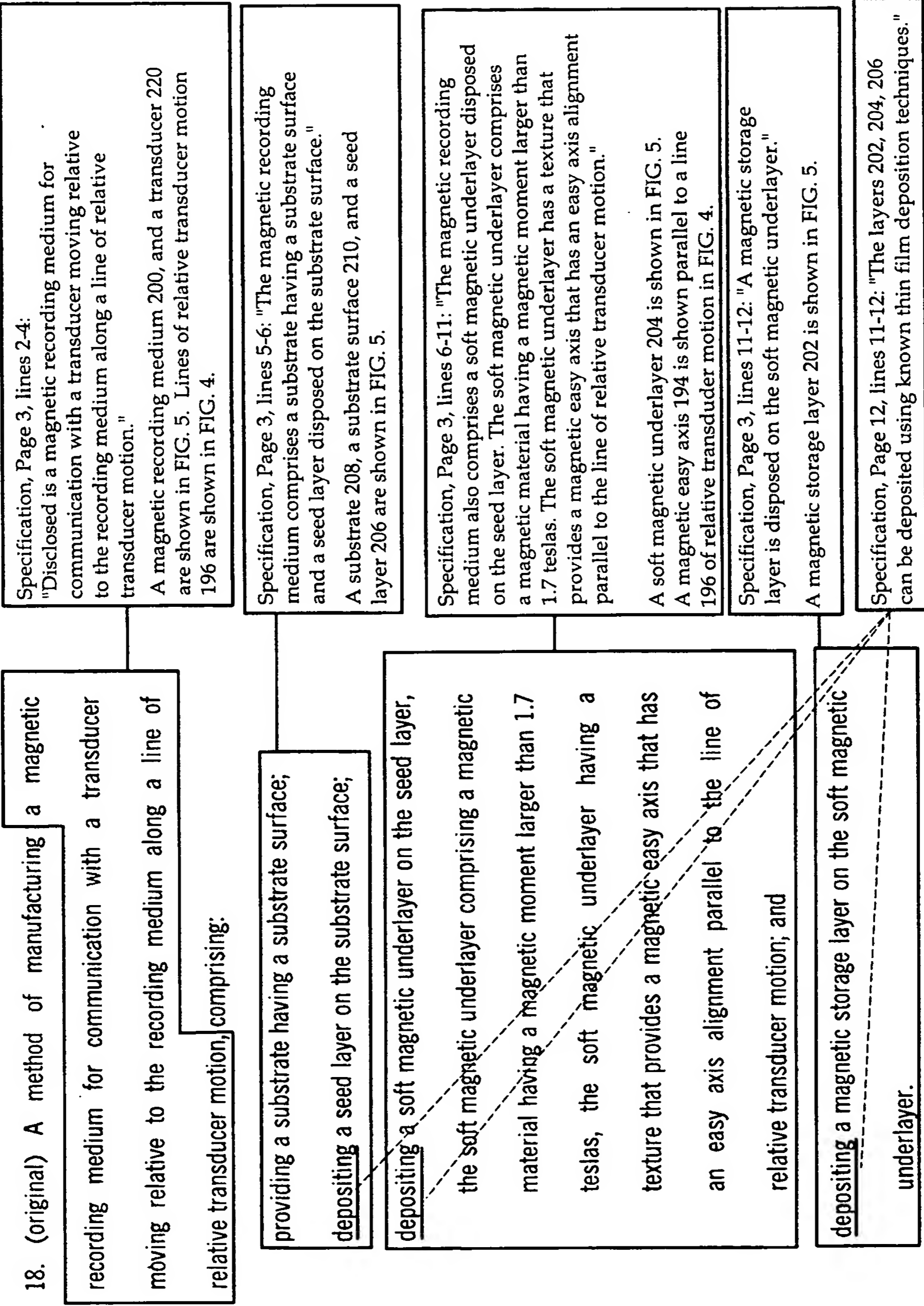
<sup>1</sup> Glaug does not appeal the rejection of claims 12 to 25 for obviousness-type double patenting. That rejection is not affected by our decision.

**(x) Related Proceedings Appendix**

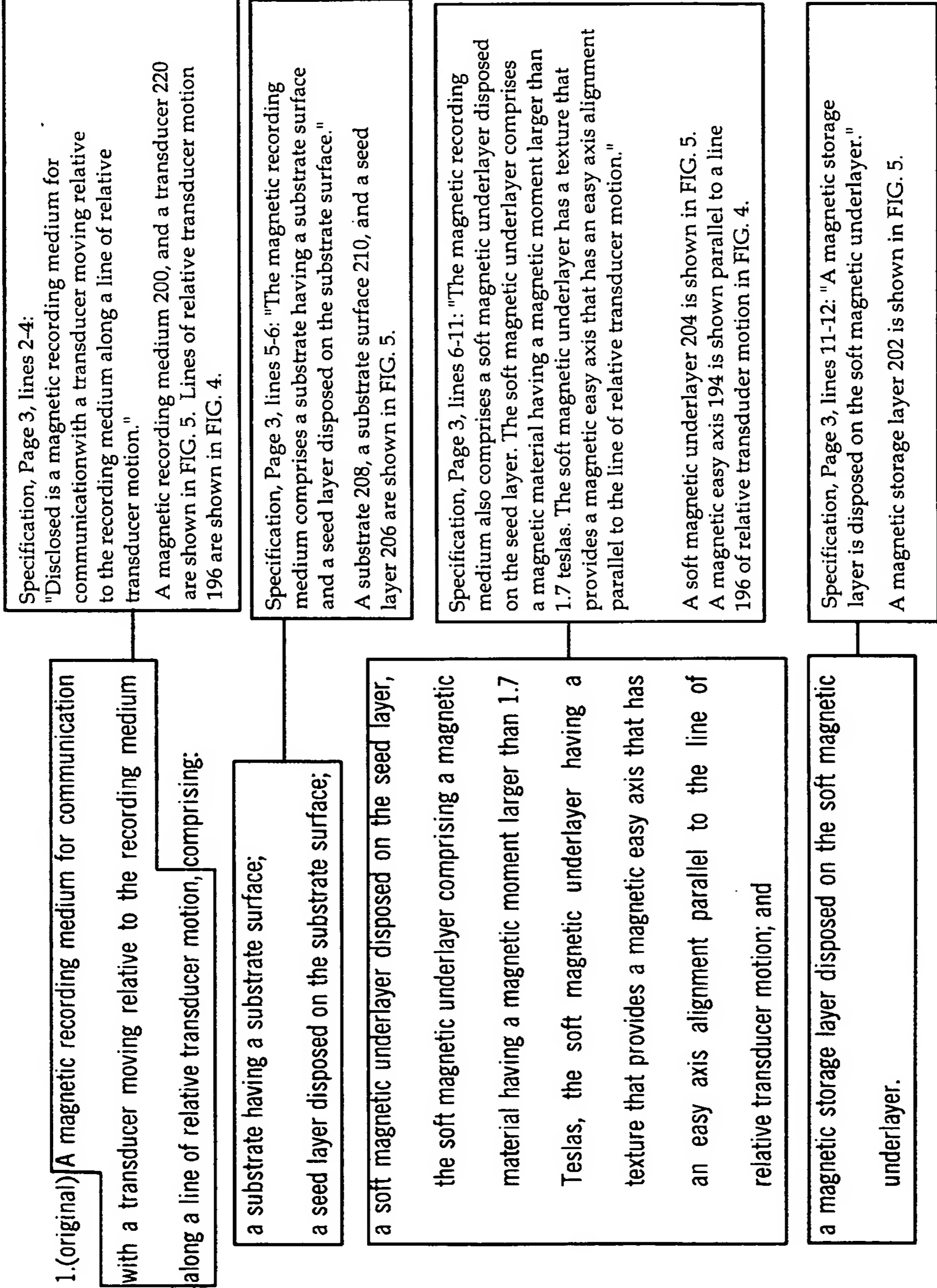
none.

(xi) Mapping of independent Claims

1. Map of Claim 1.
2. Map of Claim 18.



**Mapping of Claim 18 to the specification and drawings,  
explaining the subject matter defined in Claim 18**



**Mapping of Claim 1 to the specification and drawings,  
explaining the subject matter defined in Claim 1**

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